LAB #: Sample Report
PATIENT: Sample Patient
ID: Sample ID
SEX: Male
DOB: 01/01/1979 AGE: 45

CLIENT #: 12345
DOCTOR: Sample Doctor, MD
Doctor's Data, Inc.
3755 Illinois Ave.
St. Charles, IL 60174 U.S.A.

Toxic & Essential Elements; Hair

TOXIC METALS		RESULT µg/g	REFERENCE INTERVAL	PERCENTILE 68th 95th
Aluminum	(Al)	11	< 7.0	
Antimony	(Sb)	0.049	< 0.066	
Arsenic	(As)	0.030	< 0.080	
Barium	(Ba)	0.29	< 1.0	
Beryllium	(Be)	< 0.01	< 0.020	
Bismuth	(Bi)	0.14	< 2.0	
Cadmium	(Cd)	0.023	< 0.065	
Lead	(Pb)	0.36	< 0.80	
Mercury	(Hg)	0.57	< 0.80	
Platinum	(Pt)	< 0.003	< 0.005	
Thallium	(Tl)	0.003	< 0.002	
Thorium	(Th)	0.003	< 0.002	
Uranium	(U)	0.002	< 0.060	
Nickel	(Ni)	0.80	< 0.20	
Silver	(Ag)	0.15	< 0.08	
Tin	(Sn)	0.15	< 0.30	
Titanium	(Ti)	1.3	< 0.60	
Total Toxic Representation				

ESSENTIAL AND OTHER ELEMENTS		RESULT µg/g	REFERENCE INTERVAL	PERCENTILE 2.5th 16th 50th 84th 97.5th
Calcium	(Ca)	501	200- 750	
Magnesium	(Mg)	71	25- 75	
Sodium	(Na)	81	20- 180	
Potassium	(K)	130	9- 80	
Copper	(Cu)	9.5	11- 30	
Zinc	(Zn)	180	130- 200	
Manganese	(Mn)	0.31	0.08- 0.50	
Chromium	(Cr)	0.38	0.40- 0.70	
Vanadium	(V)	0.072	0.018- 0.065	
Molybdenum	(Mo)	0.044	0.025- 0.060	
Boron	(B)	16	0.40- 3.0	
Iodine	(I)	10	0.25- 1.8	
Lithium	(Li)	0.014	0.007- 0.020	
Phosphorus	(P)	275	150- 220	
Selenium	(Se)	0.92	0.70- 1.2	
Strontium	(Sr)	1.1	0.30- 3.5	
Sulfur	(S)	48100	44000- 50000	
Cobalt	(Co)	0.006	0.004- 0.020	
Iron	(Fe)	22	7.0- 16	
Germanium	(Ge)	0.035	0.030- 0.040	
Rubidium	(Rb)	0.15	0.011- 0.12	
Zirconium	(Zr)	0.072	0.020- 0.44	

SPECIMEN DATA

COMMENTS:

Date Collected: 06/03/2024
Date Received: 06/21/2024
Date Reported: 06/24/2024
Methodology: ICP/MS

Sample Size: 0.2 g
Sample Type: Head
Hair Color: Brown
Treatment:
Shampoo: Pantene

RATIOS

ELEMENTS	RATIOS	RANGE
Ca/Mg	7.06	4- 30
Ca/P	1.82	0.8- 8
Na/K	0.623	0.5- 10
Zn/Cu	18.9	4- 20
Zn/Cd	> 999	> 800

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 may be an indicator of exposure and 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.

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).

Thallium High

Thallium (Tl) is a highly toxic element which, like lead and mercury, accumulates in many body tissues. Hair levels reflect exposure to Tl.

Common sources of Tl are: foods (marine organisms concentrate Tl up to 700 times), rodenticides/ pesticides tobacco, contaminated water, electronics components, fly ash, cement dust, and some fertilizers. Tl is rapidly and completely absorbed when ingested, inhaled or brought into contact with skin.

Symptoms of Tl excess include: sleep disturbances, cardiac, optical, dermatatological, liver, GI, and kidney dysfunctions. Albuminuria and alopecia are consistent with Tl excess. Potassium, selenium and sulfhydryl compounds (e.g. glutathione) diminish Tl retention and toxicity. Tl toxicity can have a long latency period before clinical symptoms become apparent.

Thorium High

Correlations among the levels of Thorium (Th) in hair and other tissues have yet to be established.

Th is a radioactive element with 13 known isotopes; Th-232 constitutes 99% of the naturally-occurring Th. Th-232 is the isotope measured at DDI and reported for this sample. Th-232 has a half-life of 1.4[Exp. 10] years. It decays by alpha-emission to produce radon, Ra-228. In turn Ra-228 (half-life 6.7 years) decays to other radioactive isotopes, and eventually converts to lead. This radioactive decay process produces alpha, beta, and gamma emissions.

Th is considered mildly toxic for two reasons, the low-level radioactivity and slight biochemical toxicity. Th salts at high levels may inhibit amylase and phosphatase enzymes. Most orally ingested thorium, if not excreted in urine, binds to bone tissue where it has a long biological half-life (years).

Th has about the same abundance in the earth as does lead and is encountered in mining for titanium and rare earth elements. Commercially, Th is used in incandescent gas lantern mantles, refractory materials, and as a coating for tungsten in electronic applications. Th may also be present in tungsten-inert-gas (TIG) welding electrodes.

A urine elements analysis can be performed to assess further the extent of Th exposure.

Nickel High

Hair is a reasonable tissue for monitoring exposure to Nickel (Ni). However, hair is commonly contaminated with Ni from hair treatments and dyes. When hair Ni is measured at more than .6 ppm, the possible use of hair dyes or colorings should be investigated before concluding that excessive Ni is present. Nickel is present in a surprisingly large number of foods and food products, including:

black tea, nuts and seeds, soy milk and chocolate milk, chocolate and cocoa powders, certain canned and processed foods, including meat and fish, certain grains, including: oats, buckwheat, whole wheat and wheat germ.

There is substantial evidence that Ni is an essential element which is required in extremely low amounts. However, excess Ni has been well established to be nephrotoxic, and carcinogenic. Elevated Ni is often found in individuals who work in the electronic and plating, mining, and steel manufacture industries. A cigarette typically contains from 2 to 6 mcg of Ni; Ni is absorbed more efficiently in the lungs than in the gastrointestinal tract. Symptoms of chronic Ni exposure include dermatitis, chronic rhinitis, and hypersensitivity reactions. Ni can hypersensitize the immune system, subsequently causing hyper allergenic responses to many different substances.

Symptoms of Ni toxicity are dermatitis and pulmonary inflammation (following exposure to Ni dust, smoke). Long term or chronic Ni toxicity may lead to liver necrosis and carcinoma.

A test for elevated Ni body burden is the measurement of urine Ni before and after administration of chelating agents that mobilize Ni i.e., Ca-EDTA, DMSA.

Silver High

Hair Silver (Ag) levels have been found to reflect environmental exposure to the element. However, hair is commonly contaminated with Ag from hair treatments such as permanents, dyes, and bleaches.

Ag is not an essential element and is of relatively low toxicity. However, some Ag salts are very toxic.

Sources of Ag include seafood, metal and chemical processing industries, photographic processes, jewelry making (especially soldering), effluents from coal fired power plants and colloidal silver products.

The bacteriostatic properties of Ag have been long recognized and Ag has been used extensively for medicinal purposes; particularly in the treatment of burns. There is much controversy over the long term safety of consumption of colloidal silver. Very high intake of colloidal silver has been reported to give rise to tumors in the liver and spleen of animals (Metals in Clinical and Analytical Chemistry, eds. Seiler, Segel and Segel, 1994). However, these data may not have relevance to the effects of chronic, low level consumption by humans.

Titanium High

Titanium (Ti) is measured in hair to assist in the identification of external contamination of hair by treatments and products. Shampoos, dyes, and ”highlighting” are the primary sources of Ti, which binds tenaciously to hair.

Ti dioxide is the most common form of Ti used for industrial purposes; e.g. coating of welding rods and as white pigment in paints, dyes, and paper fillers. Ti dioxide and other Ti containing compounds have extremely low toxicity. The elevated level of Ti in the hair sample is most likely without clinical significance unless Ti implants (orthopedic, dental) are in place.

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 Low

Hair Copper (Cu) levels are usually indicative of body status with two exceptions: (1) addition of exogenous Cu (occasionally found in hair preparations or algaecides in swimming pools/hot tubs), and (2) low hair Cu in Wilson's or Menkes' diseases. In Wilson's disease, Cu transport is defective and Cu accumulates, sometimes to toxic levels, in intestinal mucosa, liver and kidneys. At the same time, it is low in hair and deficient in other peripheral tissues. In Menkes' disease, the activity of Cu dependent enzymes is very low. Cu supplementation is contraindicated in these diseases.

Cu is an essential element that is required for the activity of certain 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.

Symptoms of Cu deficiency include: elevated cholesterol, increased inflammatory responses, anemia, bone and collagen disorders, reproductive failure, and impaired immunity. Possible reasons for a Cu deficiency include: intestinal malabsorption, insufficient dietary intake,molybdenum excess,zinc excess, and chelation therapy. Cu status is adversely affected by excess of antagonistic metals such as mercury, lead, cadmium, and manganese.

Confirmatory tests for Cu deficiency are serum ceruloplasmin to rule out Wilson's disease (ceruloplasmin is deficient in Wilson's disease), a whole blood or packed red blood cell elements analysis, and a functional test for Cu (barring zinc deficiency) is measurement of erythrocytes SOD activity. Erythrocyte SOD activity is subnormal with Cu deficiency.

Chromium Low

Hair Chromium (Cr) is a good indicator of tissue levels and may provide a better indication of status than do urine or blood plasma/serum (Nielsen, F.H. In Modern Nutrition on Health and Disease; 8th Edition, 1994. Ed. Shils, Olson and Shike. Lea and Febiger, Philadelphia). Hair Cr is seldom affected by

permanent solutions, dyes and bleaches.

Cr (trivalent) is generally accepted as an essential trace element that is required for maintenance of normal glucose and cholesterol levels; it potentiates insulin function, i.e., as a part of ”glucose tolerance factor”. Deficiency conditions may include hyperglycemia, transient hyper/hypoglycemia, fatigue, accelerated atherosclerogenesis, elevated LDL cholesterol, increased need for insulin and diabetes-like symptoms, and impaired stress responses. Marginal or insufficient Cr is common in the U.S., where average tissue levels are low compared to those found in many other countries. Low hair Cr appears to be associated with increased risk of cardiovascular disease and an atherogenic lipoprotein profile (low HDL, high LDL). Common causes of deficiency are ingestion of highly processed foods, inadequate soil levels of Cr, gastrointestinal dysfunction, and insufficient vitamin B-6. Cr status is also compromised in patients with iron overload/high transferrin saturation because transferrin is a major transport protein for Cr.

Confirmatory tests for Cr adequacy include glucose tolerance and packed red blood cell elements analysis.

Vanadium High

High levels of vanadium (V) in hair may be indicative of excess absorption of the element. It is well established that excess V may have toxic effects in humans depending on the chemical form. Although it appears that V may have essential functions, over zealous supplementation should be considered with caution.

Excess levels of V in the body can also result from chronic consumption of fish, shrimp, crabs, and oysters derived from water near offshore oil rigs. Industrial/environmental sources of V include: processing of mineral ores, phosphate fertilizers, combustion of oil and coal, production of steel, and chemicals used in the fixation of dyes and print (Metals in Clinical and Analytical Chemistry, 1994). V is used in producing rust resistant, spring and high speed tool steels. Vanadium pentoxide and other vanadates are used as catalysts in the production of sulfuric acid and formaldehyde. Urban airsheds in industrialized areas have been reported to have high levels of V.

Symptoms of V toxicity vary with chemical form and route of absorption. Inhalation of excess V may produce respiratory irritation and bronchitis. Excess ingestion of V can result in decreased appetite, depressed growth, diarrhea/gastrointestinal disturbances, nephrotoxic and hematotoxic effects. Pallor, diarrhea, and green tongue are early signs of excess V and have been reported in human subjects consuming about 20 mg V/day (Modern Nutrition in Health and Disease, 8th edition, eds. Shils, M., Olson, J., and Mosha, S., 1994).

Confirmatory tests for excess V are Whole Blood Elements, and urine V which reflects very recent or ongoing exposure.

Boron High

Boron (B) is normally found in hair but the correlations among B absorption, and tissue and hair levels of B have yet to be determined. B has a low order of toxicity, but excessive intake induces riboflavinuria. Exogenous contamination of hair with B is possible since B is present in some soaps. B is also present in some cleaners, cements, ceramics, and glass.

Iodine High

Hair Iodine (I) levels have been noted to vary according to I status levels and dietary intake. I is nutritionally essential for humans and is used in the formation of thyroid hormones. I is bound to the tyrosine residue in thyroglobulin to form triiodothyronine (T-3) and thyroxine (T-4). However, there is no scientific support indicating that high hair I levels, per se, are diagnostic of thyroid function.

External contamination of hair with I from hair treatments is possible. Contamination is often accompanied by elevated aluminum, silver, nickel, and titanium if there is exogenous I contamination from hair preparations.

Conditions that may be associated with excessive I include: hypersensitivity reactions, hypothyroidism, thyroiditis, and iodide goiter. Hypersensitivity reactions can be immunologic or nonimmunologic, but usually include dermatological irritation or contact dermatoses. Other possible hypersensitivity reactions include: angio-edema, burning or soreness of mouth and throat, and nausea/diarrhea. Autonomous thyrotoxicosis (Plummer's disease) and autoimmune thyrotoxicosis (Graves' disease) may occur in I excess if thyroid function is poorly controlled by hypothalamic-pituitary action. If questionable, thyroid function should be assessed by measurement of TSH, T-4, and T-3.

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.