LAB #: Sample Report
PATIENT: Sample Patient
ID:
SEX: Male
AGE: 5

CLIENT #: 12345
DOCTOR: Sample Doctor
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)	17	< 8.0	
Antimony	(Sb)	0.096	< 0.066	
Arsenic	(As)	0.27	< 0.080	
Barium	(Ba)	0.39	< 0.50	
Beryllium	(Be)	< 0.01	< 0.020	
Bismuth	(Bi)	0.033	< 2.0	
Cadmium	(Cd)	0.054	< 0.070	
Lead	(Pb)	4.6	< 1.0	
Mercury	(Hg)	0.38	< 0.40	
Platinum	(Pt)	< 0.003	< 0.005	
Thallium	(Tl)	0.001	< 0.002	
Thorium	(Th)	0.001	< 0.002	
Uranium	(U)	0.58	< 0.060	
Nickel	(Ni)	0.17	< 0.20	
Silver	(Ag)	0.23	< 0.20	
Tin	(Sn)	0.29	< 0.30	
Titanium	(Ti)	0.71	< 1.0	
Total Toxic Representation				

ESSENTIAL AND OTHER ELEMENTS

		RESULT µg/g	REFERENCE INTERVAL	PERCENTILE 2.5th 16th 50th 84th 97.5th
Calcium	(Ca)	920	125- 370	
Magnesium	(Mg)	230	12- 30	
Sodium	(Na)	64	20- 200	
Potassium	(K)	31	12- 200	
Copper	(Cu)	30	11- 18	
Zinc	(Zn)	86	100- 190	
Manganese	(Mn)	1.4	0.10- 0.50	
Chromium	(Cr)	0.59	0.43- 0.80	
Vanadium	(V)	0.28	0.030- 0.10	
Molybdenum	(Mo)	0.15	0.050- 0.13	
Boron	(B)	8.6	0.70- 5.0	
Iodine	(I)	2.4	0.25- 1.3	
Lithium	(Li)	0.045	0.007- 0.020	
Phosphorus	(P)	200	150- 220	
Selenium	(Se)	0.63	0.70- 1.1	
Strontium	(Sr)	7.5	0.16- 1.0	
Sulfur	(S)	46300	45500- 53000	
Cobalt	(Co)	0.035	0.004- 0.020	
Iron	(Fe)	19	7.0- 16	
Germanium	(Ge)	0.034	0.030- 0.040	
Rubidium	(Rb)	0.058	0.016- 0.18	
Zirconium	(Zr)	0.61	0.040- 1.0	

SPECIMEN DATA

COMMENTS:

Date Collected: **01/02/2019**
Date Received: **01/10/2019**
Date Completed: **01/11/2019**
Methodology: **ICP/MS**

Sample Size: **0.197 g**
Sample Type: **Head**
Hair Color:
Treatment:
Shampoo: **Neutro**

RATIOS

ELEMENTS	RATIOS	RANGE
Ca/Mg	4	4- 30
Ca/P	4.6	0.8- 8
Na/K	2.06	0.5- 10
Zn/Cu	2.87	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).

Antimony High

Hair is a preferred tissue for analysis of Antimony (Sb) exposure and body burden. Elevated hair Sb levels have been noted as long as a year after exposure.

Sb is a nonessential element that is chemically similar to but less toxic than arsenic. Food and smoking are the usual sources of Sb. Thus cigarette smoke can externally contaminate hair, as well as contribute to uptake via inhalation. Gunpowder (ammunition) often contains Sb. Firearm enthusiasts often have elevated levels of Sb in hair. Other possible sources are textile industry, metal alloys, and some antihelminthic and antiprotozoic drugs. Sb is also used in the manufacture of paints, glass, ceramics, solder, batteries, bearing metals, semiconductors and fire retardant fabrics.

Like arsenic, Sb has a high affinity for sulfhydryl groups on many enzymes. Sb is conjugated with glutathione and excreted in urine and feces. Therefore, excessive exposure to Sb has the potential to deplete intracellular glutathione pools.

Early signs of Sb excess include: fatigue, muscle weakness, myopathy, nausea, low back pain, headache, and metallic taste. Later symptoms include hemolytic anemia, myoglobinuria, hematuria and renal failure. Transdermal absorption can lead to ”antimony spots” which resemble chicken pox. Respiratory tissue irritation may result from inhalation of Sb particles or dust.

A confirmatory test for recent or current exposure is the measurement of Sb in the urine or whole blood. Comparison of pre and post provocation (DMPS, DMSA, Ca-EDTA) urine Sb levels provides an estimate of net retention (body burden) of Sb.

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 be associated with toxicity. Inorganic As accumulates in hair, nails, skin, thyroid gland, bone and the gastrointestinal tract. Organic As, such as that derived from shellfish, 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), drinking 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. Generally, hair is a good indicator of exposure to 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 does occur.

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 fertilizers, industrial pollution, lead-glazed pottery, Ayruvedic herbs and use of firearms.
Tests for Pb body burden are: urine elements analysis following provocation with intravenous Ca-EDTA, or oral DMSA. Whole blood analysis for Pb reflects recent or ongoing exposures and does not correlate well with total body burden.

Uranium High

The levels of Uranium (U) in hair usually reflect levels of U in other tissues. However, hair may be externally contaminated by shampoos or hair products that contain U.

U is a nonessential element that is very abundant in rock, particularly granite, lignite, monazite sands, and phosphate rocks. U is present at widely varying levels in drinking water, root vegetables, and present in high phosphate fertilizers. Other sources of U include: ceramics, some colored glass, many household products and tailings from U mines. Spent U rods have been milled into armor piercing bullets and missile heads.

Uranyl cations bind tenaciously to protein, phosphate, nucleotides, and bone, where it substitutes for Ca. Published data are sparse, but there appears to be a correlation between U exposure, nephrotoxicity and cancer. Kidney and bone are the primary sites of U accumulation.

All isotopes of U are radioactive; 238U is the most abundant and lowest energy emitter. It is important to note that the measured result, which is 238U, does NOT necessarily indicate or imply exposure to highly enriched 235U, which is used in nuclear power and weaponry.

Chronic fatigue is often reported in association with hair U levels >0.5 µg/g (DDI observations). U is rapidly cleared from blood and deposited in tissues. Currently, DTPA is the only effective chelating agent for ACUTE U poisoning. However, it must be administered immediately and is not effective once U has transferred from blood to tissues. Currently there are no available chelators or complexing agents that have been established to be effective for ameliorating U

retention associated with long-term, low-level exposure to U.

Urine or fecal elements analysis can be performed to confirm recent or ongoing exposure to U. Because U is such a potent nephrotoxin, one might test for urinary wasting of amino acids and low molecular weight proteins (B-2-microglobulin) in patients with markedly elevated hair U levels.

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.

Calcium High

Hair Calcium (Ca) levels have been correlated with nutritional intake, several disease syndromes, and metabolic disorders. However, hair Ca is sensitive to contamination by permanent solutions, dyes or bleaching. If hair has been treated, the reported Ca level is likely to be artifactually high and not indicative of Ca status or metabolism.

When external contamination is ruled out, elevated Ca is most often interpreted as a maldistribution of Ca. Rarely is elevated hair Ca indicative of excess dietary Ca. However, overzealous supplementation is possible. A high result for hair Ca is more likely to be indicative of an inappropriately low ratio of dietary Ca : phosphorus. Conditions associated with elevated hair Ca include but are not limited to: hyperparathyroidism, osteoporosis, excess dietary Ca or protein, excess vitamins A and/or D, phosphorus/magnesium/calcium imbalance (assessed by whole blood element analysis), hypoglycemia, hormonal imbalances, and metabolic disorders.

Hair analysis is not the preferred way to assess body Ca stores. Ca status should be assessed through: dietary analysis, whole blood or serum Ca level, vitamin A and D levels, blood concentrations of other electrolytes (sodium, magnesium, potassium), parathyroid hormone determinations, and bone density measurement.

Magnesium High

Magnesium (Mg) is an essential element with both electrolyte and enzyme-activator functions. However, neither of these functions takes place in hair. Body excess of Mg is rare but may occur from excessive oral or parenteral supplementation or as a result of renal damage or insufficiency.

If one rules out external contamination of hair as a result of recent hair treatment, elevated hair Mg is more likely to indicate maldistribution of the element. Physiological Mg dysfunction may or may not be present. Maldistribution of Mg can occur as a result of chronic emotional or physical stress, toxic metal or chemical exposure, physiological imbalance of calcium and phosphorus, bone mineral depletion, and renal insufficiency with poor clearance of Mg (and other metabolites). Elevated hair Mg has been correlated with hypoglycemia and an inappropriately low ratio of dietary Ca : P.

Mg status can be difficult to assess; whole blood and packed blood red cell Mg levels are more indicative than serum/plasma levels Amino acid analysis can be helpful in showing rate-limited steps that are Mg-dependent (e.g. phosphorylations).

Copper High

The high level of Copper (Cu) in hair may be indicative of excess Cu in the body. However, it is important first to rule out exogenous contamination sources: permanent solutions, dyes, bleaches, swimming pool/hot tub water, and washing hair in acidic water carried through Cu pipes. In the case of contamination from hair preparations, other elements (aluminum, silver, nickel, titanium) are usually also elevated.

Sources of excessive Cu include contaminated food or drinking water, excessive Cu supplementation, and occupational or environmental exposures. Insufficient intake of competitively absorbed elements such as zinc or molybdenum can lead to, or worsen Cu excess.

Medical conditions that may be associated with excess Cu include: biliary obstruction (reduced ability to excrete Cu), liver disease (hepatitis or cirrhosis), and renal dysfunction. Symptoms associated with excess Cu accumulation are muscle and joint pain, depression, irritability, tremor, hemolytic anemia, learning disabilities, and behavioral disorders.

Confirmatory tests for Cu excess are a comparison of Cu in pre vs. post provocation (D-penicillamine, DMPS) urine elements tests and a whole blood elements analysis.

Zinc Low

A result of low hair Zinc (Zn) may 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. Other laboratory tests to confirm Zn status are whole blood or packed red blood cell elements analysis.

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 would healing, sexual dysfunction (males), and hypogonadism.

Manganese High

Hair Manganese (Mn) levels generally reflect exposure to Mn, but external contamination can influence hair Mn. High hair Mn can be an artifact of contamination from: permanent solutions, dyes, bleaches, and well water (containing high Mn). These possibilities should be considered and ruled out before proceeding with therapies to alleviate excess Mn.

Mn is an essential element which is involved in the activation of many important enzymes. However, Mn excess is postulated to result in glutathionyl radical formation, reduction of the free glutathione pool, and increased exposure of adrenal catecholamines (e.g. dopamine) to free radical damage. Excess Mn causes degeneration of melanin-pitmented dopaminergic neurons which results in abnormally low levels of serotonin and dopamine in the brain. This is hypothesized to be a reason behind the neurotoxic effects attributed to Mn overload.

The brain is particularly affected by Mn excess. Symptoms or conditions consistent with excessive Mn include: disorientation, memory loss, anxiety, hypotonia, abnormal gait, emotional instability, and bipolar-like behaviors (laughing and crying), aberrant or violent behaviors, and tremor or Parkinson-like symptoms.

Causes of Mn excess include: occupational or environmental exposures, contaminated teas, MMT (gasoline additive), coal-fired power plants,contaminated drinking water, some street drugs (cocaine products), and smoking. Conditions predisposing to Mn excess are: iron or calcium deficiency, chronic infection, and impaired liver function (e.g. biliary obstruction) or disease. Mn excess is occasionally associated with alcoholism.

Confirmatory tests for Mn excess include whole blood and a comparison of urine Mn pre- and post Ca-EDTA.

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 can have toxic effects in humans. Although it appears that V may have essential functions, over zealous supplementation is not warranted.

Excess levels of V in the body can result from chronic consumption of fish, shrimp, crabs, and oysters derived from water near offshore oil rigs (Metals in Clinical and Analytical Chemistry,

1994). 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.

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 red blood cell elements analysis, and urine V which reflects recent intake.

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.

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, 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.

Strontium High

Hair usually reflects the body burden of Strontium (Sr), and Sr levels usually correlate with calcium levels in body tissue. However, hair levels of Sr can be raised by external contamination, usually from hair treatment products. Elevated Sr in hair treated with permanent solutions, dyes, or bleaches is likely to be an artifact of hair treatment and probably does not reflect the level of Sr in other tissues.

Diseases of excess Sr have not been reported, except for Sr rickets. In general, Sr excess is not of clinical concern in the U.S. It's bad reputation comes from it's radioactive isotopes which were widespread in the western U.S. as a result of nuclear testing in the 1950's. Stable Sr (not radioactive Sr) is measured and reported by DDI.

Other tests indicative of Sr status or excess are measurements of Sr in whole blood, Sr/calcium ratio in blood, and Sr in urine.

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.