Elemental Analysis Hair

Great Smokies Diagnostic Laboratory℠
63 Zillicoa Street · Asheville, NC 28801-1074
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Patient:
Age:
Sex:
MRN:

Order Number:
Completed:
Received:
Collected:

INSTITUUT VOOR FUNCTIONELE GENEESKUNDE E
Nieuweweg 172
6603 BT Wijchen
,
THE NETHERLANDS

Toxic Elements

Analyte		Reference Range
Aluminum	11.6	<=9.0
Antimony	<0.025	<=0.030
Arsenic	0.099	<=0.100
Barium	0.19	<=1.45
Bismuth	<0.0250	<=0.2000
Cadmium	<0.025	<=0.150
Lead	2.41	<=0.50
Mercury	1.42	<=1.00
Nickel	0.204	<=0.400
Thallium	<0.0003	<=0.0012
Tin	0.114	<=0.280
Uranium	0.074	<=0.060

Reference

Reference range expressed in ppm

Additional Elements

Analyte		Reference Range
Sodium	74	8-60
Potassium	58.5	1.5-30.0
Rubidium	0.059	0.004-0.045
Iron	10.7	6.0-18.0
Phosphorous	152	125-240
Titanium	0.66	0.25-1.25

Reference

Reference range expressed in ppm

Nutrient Elements

Analyte		Reference Range
Calcium	168	220-780
Magnesium	15	15-90
Copper	103.6	9.0-23.0
Zinc	41	105-175
Manganese	0.18	0.14-0.40
Chromium	0.82	0.34-0.90
Cobalt	0.0103	0.0075-0.0400
Molybdenum	0.132	0.025-0.096
Boron	5.16	0.15-3.00
Iodine	0.70	0.16-1.75
Lithium	0.0364	0.0027-0.0320
Selenium	0.95	0.48-1.45
Strontium	1.66	0.35-3.25
Sulfur	53,413	44,200-53,000
Vanadium	0.126	0.014-0.150

Reference

Reference range expressed in ppm

Within FPR* | Outside FPR* | Outside Ref Range

	Inside Range	Outside Range	Reference
Ca/Mg	11.2		5.0-15.0
Ca/P		1.1	2.5-10.0
Na/K		1.3	1.5-10.0

20% 40% 60% 80% 100%
The % of shading represents the degree of confidence in an endogenous origin of the element.

Histograms on this report are not based on data from large populations and should be used for illustrative purposes only.

 RMS 60, Rev1

* The Functional Physiological Range (FPR) depicts a medical decision interval. Values outside of the FPR are not necessarily abnormal. Rather, the FPR has been established by GSDL's Department of Medical Science based upon current medical literature, collective clinical experience and consensus medical opinion.

Commentary

Commentary is provided to the practitioner for educational purposes, and should not be interpreted as diagnostic or treatment recommendations. Diagnosis and treatment decisions are the responsibility of the practitioner.

Aluminum (Al) is at an elevated level in the hair. Hair Al level reflects past or chronic exposure to this element. Al can impair cellular energy transfer processes by interfering with phosphate and ATP metabolism. Neuronal cells are susceptible to long term accumulation of Al, and Al bonding to phosphate can inhibit normal catabolism of neuronal filaments in the CNS. Correlation of elevated Al with degenerative dementia and Alzheimer's disease has been documented. Excessive dietary Al can also form insoluble aluminum phosphates in the GI tract and may lead to hypophosphatemia. Symptoms of elevated Al may include fatigue, headache and signs of phosphate depletion. However, low level Al exposures may not provoke any immediate symptoms.

Hair is easily contaminated with Al from hair treatment and possibly by wash water if it is high in Al content. The probability of contamination is reflected by the shading of the circle for Al on the lab report.

Lead (Pb) is at an elevated level in the hair. Hair Pb level correlates with body tissue deposition levels (bone, aorta, liver, kidney) and also correlate with blood levels if the exposure is periodic or chronic.

At the cellular level, lead interferes with membrane transport processes and with enzyme functions because it is able to bond to many chemically active sites. The interaction of lead with sulfhydryl (SH) sites causes most of the toxic effects which include impaired heme synthesis, inhibition of erythrocyte Na, K ATPase, diminished RBC glutathione, shortened RBC life span, impaired synthesis of RNA, DNA and protein and impaired metabolism of vitamin D. Lead may also be nephrotoxic, resulting in disordered renal transport with uricemia (possibly gout), hyperaminoaciduria, glycosuria and phosphaturia. Excess body burden of Pb can be consistent with fatigue, headaches, loss of appetite, insomnia, nervousness, anemia, weight loss, decreased nerve conduction and possibly motor neuron disorders.

Hair is sensitive to external contamination with Pb. Elevated hair Pb may be an artifact of certain hair preparations, especially dyes and darkening agents, e.g. "Grecian Formula". The probability of such contamination is reflected by the shading of the circle for Pb on the lab report.

Mercury (Hg) is at an elevated level in the hair. Hair Hg correlates with: Hg deposition in body tissues (kidneys, epithelium, pancreas, testicles, prostate, thyroid, liver), the number and size of dental amalgams, regular ingestion of fish, and blood Hg level when the Hg exposure is periodic or chronic. Both methylated and nonmethylated mercury are readily transported via mother's milk. Transplacental Hg contamination can occur, and hair of neonates and mothers correlate closely.

Manifestations of mercury excess can depend upon the chemical form and mode of exposure, metabolic status and levels of protective nutrients (vitamin E, selenium), the presence of synergistic toxins (cadmium, lead), and immune function. Hg binds to sulfur-bearing proteins and enzymes and has strong affinity for sulfhydryl groups (SH) such as glutathione, cysteine, and enzymes such as monoamine oxidase.

Mild mercury toxicity may result in reduced sensory abilities (taste, touch, vision and hearing), metallic taste with increased salivation, fatigue and anorexia. Chronic exposures may adversely affect lymphocyte activity, result in autoimmune complexes and increased risk for cardiovascular disease. Moderate and severe mercury excess can result in paresthesias, hypertension with renal dysfunction, irritability and excitability, psychoses, mania, anemia, tremors and incoordination.

Uranium (U) is at an elevated level in the hair. Experience* suggests hair level of uranium reflects past or chronic ingestion. Most exposure comes from natural uranium in ground and drinking water. The U238 isotope of uranium is

Commentary

measured by GSDL, and this isotope comprises more than 99% of naturally occurring uranium. Radioactivity danger from trace quantities of natural uranium is slight because of its very long half life (billions of years). The finding of elevated U238 in this test does not imply nor does it rule out exposure to enriched uranium fuel (U235) or to other radioactive isotopes which may be radiation hazards.

The major toxicological concern of U238 excess is biochemical rather than radiochemical. U is a reactive element which is able to combine with and affect the metabolisms of: lactate, citrate, pyruvate, carbonate and phosphate. Eventually, U deposits in kidney, bone, liver and spleen. The primary symptom of low level chronic uranium excess is chronic fatigue. Possible conditions from more severe uranium contaminations include damage to kidney glomeruli with disordered renal transport (proteinuria, albuminuria, and hyperaminoaciduria) and hematopoiesis in bone marrow.

Hair is sensitive to external contamination with U, possibly coming from shampoos or wash water. The probability of such contamination is reflected by the shading of the circle for U on the lab report.

Calcium (Ca) is at a depressed level in the hair. Low hair Ca is consistent with dietary Ca or vitamin D deficiency, protein deficiency, malabsorption syndromes and excessive intestinal alkalinity. Increases in acidophilic intestinal flora favor Ca uptake. Low hair Ca is noted for pre and post myocardial infarct, vascular calcification, decreased cerebral blood flow, hormonal imbalances, periodontal disease, aplastic anemia and kidney dialysis. Chemical or elemental toxicity conditions often feature deficient Ca as measured in the hair. Symptoms associated with Ca insufficiency may include muscle cramps or twitching, carpopedal spasm, excessive menstrual cramping, facial muscle spasm (Chvostek's sign) and myalgia.

Copper (Cu) is at an elevated level in the hair. Hair Cu correlates with tissue levels except in copper loading diseases.

Elevated hair Cu may coincide with: zinc or molybdenum deficiency, biliary insufficiency or obstruction, cirrhosis or chronic hepatitis and copper toxicity. Copper toxicity may feature tremor, dementia, Parkinsonism, hemolytic anemia, jaundice and renal damage. Occasionally, emotional instability, aggressive or violent behaviors, are seen in individuals with elevated hair Cu. Suggested for further assessment of copper status are the following measurements: copper amino acid carriers in plasma (histidine, threonine, glutamine), serum ceruloplasmin, erythrocyte Cu content and urinary Cu.

Elevated hair copper may be an artifact of exposure to swimming pool water where Cu algicides are used, and of hair treatments or shampoos. Acidic wash water carried through copper pipes can also affect the hair Cu level. The probability of such contamination is reflected by the shading of the circle for Cu on the lab report.

Zinc (Zn) is at a depressed level in the hair. Low hair zinc correlates with low tissue levels and possible inadequate Zn function. Low hair Zn may be the result of poor dietary intake, digestive dysfunction, malabsorption syndromes, chronic diarrhea, or excessive tissue levels of copper or iron.

Many possible physiological dysfunctions or disease conditions may be coincident with Zn inadequacy. These include: impaired taste or smell, poor night vision, fatigue, dermatoses, sexual dysfunction, growth retardation in children and (partial) alopecia. Conditions which have been associated with low hair Zn include: maldigestion, celiac disease, chronic hepatitis, sickle cell anemia, kidney dialysis, cancer, anorexia, obesity and Wilson's disease. Low hair Zn has also been noted in premature birth babies and their mothers, as well as mothers of infants with spina bifida.

Manganese (Mn) is within the reference range. The reported level of Mn may reflect external contamination from hair preparations which contribute to the measured level. The probability of such contamination is reflected by the shading of the circle for Mn on the lab report.

Chromium (Cr) levels is within the reference range. Hair Cr has been reported to correspond to nutritional and physiological status. However, hair Cr occasionally reflects contamination from hair preparations, which contribute to

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the measured level. The probability of such contamination is reflected by the shading of the circle for Cr on the lab report.

Cobalt (Co) level is within the reference range. However, hair Co levels occasionally reflect external contamination from hair preparation products. Occupational or environmental exposures to Co dusts or chemicals may cause exogenous contamination. The probability of contamination is reflected by the shading of the circle for Co on the lab report.

Molybdenum (Mo) is at an elevated level in the hair. Hair Mo reflects ingestion and tissue levels, but may not reflect its function as an enzyme activator. Occupational or environmental exposures to Mo are an unusual occurrence, although copper deficiency can increase Mo uptake and retention. Mo excess may result in anorexia, anemia and headache. Elevated Mo may cause arthritic symptoms if copper is deficient.

Boron (B) is at an elevated level in the hair. Experience* suggests hair levels of B may reflect longterm ingestion. Ingested B is well absorbed into the blood stream and rapidly deposited in tissues (brain, bone, heart, spleen, kidney, liver, testicles). Effects of excess B depend strongly upon chemical form and mode of exposure. Elemental boron has low toxicity while borates and boranes can have cumulative neurotoxic effects. Boranes interfere with pyridoxal phosphate-dependent metabolic steps for amino acids. Symptoms may include dizziness, muscular tremors and incoordination.

Boron is sensitive to contamination from hair preparation products, which may contribute to the measured level of hair B. Additionally, increased body burdens of toxic elements or organic chemicals are observed * to raise hair B levels, without evidence of B excess itself. Thus, elevated B may be due to a combination of factors - endogenous excess, external contamination, and maldistribution secondary to toxic excesses.

Iodine (I) level is within the reference range. Hair is indicative of past ingestion of I and of health conditions relating to deficiency or excess. The reported I level may include some external contamination by hair preparation products. The probability of such contamination is reflected by the shading of the circle for iodine on the lab report.

Lithium (Li) is at an elevated level in the hair. Hair Li correlates with tissue levels and with longterm dietary intake of Li. Additionally, Li level has been reported to correlate with lithium carbonate therapy.

Elevated hair Li is consistent with increased dietary intake, usually from ground water, and with use of lithium salts in bathing. Very elevated hair Li often corresponds to lithium therapy. Excessive Li ingestion may provoke hypotension, edema, nausea and mental confusion. Blood serum measurement is advised for monitoring therapeutic Li level.

Selenium (Se) level is within the reference range. However, hair Se levels may reflect external contamination from Se-containing shampoos, which can contribute to the measured level. The probability of such contamination is reflected by the shading of the circle for Se on the lab report.

Sulfur (S) is at an elevated level in the hair. Hair is structurally dependent upon sulfur for its formation, growth, health and appearance. Experience* suggests hair levels of sulfur reflects the status of important sulfur bearing amino acids: cysteine, cystine, and taurine. However, elevated hair S may also reflect addition of external S from hair conditioning or permanent treatments. The probability of such contamination is reflected by the shading of the circle for S on the lab report.

Elevated hair S of endogenous origin is very unusual but may occur in renal insufficiency, biliary insufficiency and possibly in cystinosis. "Sulfite/sulfate imbalances", sulfite oxidase deficiency (possibly molybdenum deficiency) may feature elevated blood, urine and hair levels of cysteine, taurine and sulfur. Amino acid and enzyme analyses may be considered for follow up testing for such conditions.

The lab report lists six elements in a grouping entitled "Other." In hair, these elements do not correlate with blood or other tissue levels, but they can be markers for contamination or may have special meaning. Hair sodium levels are

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very subject to external contamination by shampoos and hair treatment products, which may contribute to the measured levels. Hair potassium is less subject to external contamination. Hair sodium and potassium vary with metabolic, homeostatic and stress conditions. Rubidium is a relatively benign element which typically parallels the potassium level. It varies according to levels found in water supplies. At extremely high levels, Rb may compete with potassium for activity in the cellular potassium pump; in practical terms this is rarely seen. Hair iron is not usually reflective of iron status but can be a marker for external contamination. Additionally, elevated hair iron may be found in smokers, x- ray technicians and individuals with certain forms of cancer. Notably low or high hair phosphorus is consistent with abnormal calcium and/or magnesium metabolism. Hair phosphorus also is typically elevated with kidney dialysis, and appears to be depressed in chronic hepatitis. Hair phosphorus is seldom altered by external influences. Hair is extremely susceptible to contamination with titanium from hair treatment products. Most common forms of titanium are inert, insoluble and nontoxic, especially titanium dioxide pigment. Titanium is included in this analysis as an indicator for external contamination of hair with various elements.

* (if present): Observations of Bob Smith, Vice President, Elemental Analysis, who has approximately 20 years experience working with hair analysis reports.