LAB #: U170313-2197-1
PATIENT: Stephen Russell
ID: RUSSELL-S-00815
SEX: Male
AGE: 43

CLIENT #: 42158
DOCTOR: Ha Dang, ND
Marin Naturopathic Medicine
2144 4th St #b
San Rafael, CA 94901 U.S.A.

Toxic Metals; Urine

TOXIC METALS		RESULT µg/g creat	REFERENCE INTERVAL	WITHIN REFERENCE / OUTSIDE REFERENCE
Aluminum	(Al)	**3.4**	< 25	
Antimony	(Sb)	**0.4**	< 0.2	
Arsenic	(As)	**10**	< 75	
Barium	(Ba)	**2.2**	< 7	
Beryllium	(Be)	**< dl**	< 1	
Bismuth	(Bi)	**66**	< 2	
Cadmium	(Cd)	**0.2**	< 0.8	
Cesium	(Cs)	**6.9**	< 9	
Gadolinium	(Gd)	**< dl**	< 0.5	
Lead	(Pb)	**3.3**	< 2	
Mercury	(Hg)	**3.4**	< 3	
Nickel	(Ni)	**2.4**	< 8	
Palladium	(Pd)	**< dl**	< 0.1	
Platinum	(Pt)	**< dl**	< 0.1	
Tellurium	(Te)	**< dl**	< 0.5	
Thallium	(Tl)	**0.3**	< 0.5	
Thorium	(Th)	**< dl**	< 0.03	
Tin	(Sn)	**4.1**	< 4	
Tungsten	(W)	**0.06**	< 0.4	
Uranium	(U)	**< dl**	< 0.03	

URINE CREATININE	RESULT mg/dL	REFERENCE INTERVAL	-2SD -1SD MEAN +1SD +2SD
Creatinine	**105**	35 - 240	

SPECIMEN DATA

Comments:

Date Collected: **03/09/2017**
Date Received: **03/13/2017**
Date Completed: **03/15/2017**
Method: **ICP-MS**

pH upon receipt: **Acceptable**
<dl: **less than detection limit**
Provoking Agent: **DMPS 250MG**
Creatinine by Jaffe Method

Collection Period: **timed: 6 hours**
Volume:
Provocation: **POST PROVOCATIVE**

Results are creatinine corrected to account for urine dilution variations. **Reference intervals and corresponding graphs are representative of a healthy population under non-provoked conditions.** Chelation (provocation) agents can increase urinary excretion of metals/elements.

V13

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Essential Elements; Urine

ESSENTIAL AND OTHER ELEMENTS		RESULT/UNIT per creatinine		REFERENCE INTERVAL	PERCENTILE 2.5th 16th 50th 84th 97.5th
Sodium	(Na)	**67**	mEq/g	40- 200	
Potassium	(K)	**59**	mEq/g	20- 90	
Phosphorus	(P)	**400**	µg/mg	150- 1000	
Calcium	(Ca)	**120**	µg/mg	20- 250	
Magnesium	(Mg)	**70**	µg/mg	20- 200	
Zinc	(Zn)	**2.5**	µg/mg	0.09- 1.3	
Copper	(Cu)	**0.24**	µg/mg	0.006- 0.06	
Sulfur	(S)	**950**	µg/mg	275- 1000	
Manganese	(Mn)	**0.003**	µg/mg	0.0003- 0.005	
Molybdenum	(Mo)	**0.03**	µg/mg	0.01- 0.13	
Boron	(B)	**3**	µg/mg	0.4- 3.5	
Chromium	(Cr)	**< dl**	µg/mg	0.0002- 0.002	
Lithium	(Li)	**1.1**	µg/mg	0.008- 0.18	
Selenium	(Se)	**0.027**	µg/mg	0.03- 0.2	
Strontium	(Sr)	**0.13**	µg/mg	0.035- 0.32	
Vanadium	(V)	**0.0002**	µg/mg	0.0001-0.0015	
					68th 95th
Cobalt	(Co)	**< dl**	µg/mg	< 0.007	
Iron	(Fe)	**0.26**	µg/mg	< 1	

URINE CREATININE	RESULT mg/dL	REFERENCE INTERVAL	-2SD -1SD MEAN +1SD +2SD
Creatinine	**105**	35- 240	

SPECIMEN DATA

Comments:

Date Collected: **03/09/2017**
Date Received: **03/13/2017**
Date Completed: **03/15/2017**
pH Upon Receipt: **Acceptable**
<dl: **less than detection limit**
Provoking Agent: **DMPS 250MG**
Collection Period: **timed: 6 hours**
Volume:
Provocation: **POST PROVOCATIVE**

Method: ISE;Na, K Spectrophotometry; P ICP-MS; B, Ca, Cr, Co, Cu, Fe, Mg, Mn, Mo, Se, Sr, S, V, Zn Creatinine by Jaffe method

Results are creatinine corrected to account for urine dilution variations. **Reference intervals and corresponding graphs are representative of a healthy population under non-provoked conditions.** Chelation (provocation) agents can increase urinary excretion of metals/elements.

V13

INTRODUCTION

This analysis of urinary elements was performed by ICP-Mass Spectroscopy following acid digestion of the specimen. Urine element analysis is intended primarily for: diagnostic assessment of toxic element status, monitoring detoxification therapy, and identifying or quantifying renal wasting conditions. It is difficult and problematic to use urinary elements analysis to assess nutritional status or adequacy for essential elements. Blood, cell, and other elemental assimilation and retention parameters are better indicators of nutritional status.

1) 24 Hour Collections
"Essential and other" elements are reported as mg/24 h; mg element/urine volume (L) is equivalent to ppm. "Potentially Toxic Elements" are reported as µg/24 h; µg element/urine volume (L) is equivalent to ppb.

2) Timed Samples (< 24 hour collections)
All "Potentially Toxic Elements" are reported as µg/g creatinine; all other elements are reported as µg/mg creatinine. Normalization per creatinine reduces the potentially great margin of error which can be introduced by variation in the sample volume. It should be noted, however, that creatinine excretion can vary significantly within an individual over the course of a day.

If one intends to utilize urinary elements analysis to assess nutritional status or renal wasting of essential elements, it is recommended that unprovoked urine samples be collected for a complete 24 hour period. For provocation (challenge) tests for potentially toxic elements, shorter timed collections can be utilized, based upon the pharmacokinetics of the specific chelating agent. When using EDTA, DMPS or DMSA, urine collections up to 12 hours are sufficient to recover greater than 90% of the mobilized metals. Specifically, we recommend collection times of: 9 - 12 hours post intravenous EDTA, 6 hours post intravenous or oral DMPS and, 6 hours post oral bolus administration of DMSA. What ever collection time is selected by the physician, it is important to maintain consistency for subsequent testing for a given patient.

If an essential element is sufficiently abnormal per urine measurement, a descriptive text is included with the report. Because renal excretion is a minor route of excretion for some elements, (Cu, Fe, Mn Zn), urinary excretion may not influence or reflect body stores. Also, renal excretion for many elements reflects homeostasis and the loss of quantities that may be at higher dietary levels than is needed temporarily. For these reasons, descriptive texts are provided for specific elements when deviations are clinically significant. For potentially toxic elements, a descriptive text is provided whenever levels are measured to be higher than expected. If no descriptive texts follow this introduction, then all essential element levels are within acceptable range and all potentially toxic elements are within expected limits.

Reference intervals and corresponding graphs shown in this report are representative of a healthy population under non-provoked conditions. Descriptive texts appear in this report on the basis of measured results and correspond to non-challenge, non-provoked conditions.

Chelation (provocation) agents can increase urinary excretion of metals/elements. Provoked

reference intervals have not been established therefore non-provoked reference intervals shown are not recommended for comparison purposes with provoked test results. Provoked results can be compared with non-provoked results (not reference intervals) to assess body burden of metals and to distinguish between transient exposure and net retention of metals. Provoked results can also be compared to previous provoked results to monitor therapies implemented by the treating physician. Additionally, Ca-EDTA provoked results can be used to calculate the EDTA/Lead Excretion Ratio (LER) in patients with elevated blood levels.

CAUTION: Even the most sensitive instruments have some detection limit below which a measurement cannot be made reliably. Any value below the method detection limit is simply reported as "< dl." If an individual excretes an abnormally high volume of urine, urinary components are likely to be extremely dilute. It is possible for an individual to excrete a relatively large amount of an element per day that is so diluted by the large urine volume that the value measured is near the dl. This cannot automatically be assumed to be within the reference range.

ANTIMONY HIGH

This individual's urine antimony (Sb) is higher than expected, but potential associated symptoms and toxic effects may not be present. This is because antimony has two valences: Sb+3 and Sb+5. Sb+3 is inherently the more toxic but is mostly excreted in feces. Sb+5, less toxic, binds less well to body tissues and is excreted mostly in urine. The current analysis does not differentiate the two forms of Sb.

Antimony can be assimilated by inhalation of Sb salt or oxide dust, ingested with (contaminated) foods or fluids, or absorbed transdermally. Inhalation may occur in industrial areas that involve smelting or alloying is done (usually with copper, silver, lead, tin). Sb is present in tobacco at about 0.01% by weight; about 20% of this is typically inhaled by cigarette smoking (Carson et al., Toxicology and Biological Monitoring of Metals in Humans, Lewis Pub. p. 21, 1987). Antimony compounds are used for fireproofing textiles and plastics, and this element may be found in battery electrodes, ceramics and pigments. Antimony can be absorbed with the handling of gun powder or the frequent use of firearms. Recent studies indicate high levels of antimony in sheepskin bedding produced in New Zealand. Antimony contamination of soft plastic-bottled water is time and temperature dependent.

Symptoms of mild Sb exposure/retention may be insidious and multiple including: fatigue, muscle weakness, myopathy, and metallic taste. Chlorides and oxides of both valences of Sb can be mutagenic and may affect leukocyte function. Sb can bond to sulfhydryl (-SH) sites on enzymes and may interfere with cellular metabolism. Acute symptoms that may be associated with excessive Sb exposure/retention include: respiratory tissue irritation and pneumoconiosis with (chronic) inhalation of Sb dusts, RBC hemolysis with inhalation of stibine (SbH_3) vapor, and gastrointestinal distress if orally ingested. Skin exposure can produce "antimony spots" or rashes which resemble chicken pox. Certain molds can produce the highlyneurotoxic stibine gas from Sb; stibine inhibits acetylcholinestelase activity.

A hair element analysis may be used to further assess Sb exposure. Antimony may

be elevated in urine following administration of DMPS or DMSA if exposures to Sb have resulted in net retention; such levels may or may not be associated with overt adverse health effects.

BIBLIOGRAPHY FOR ANTIMONY
1. Carson B.L. et al. Toxicology and Biological Monitoring of Metals in Humans, Lewis Publishers, Chelsea MI, pp 21-26, 1987.
2. Tsalev D.L. and Z.K. Zaprianov. Atomic Absorption Spectrometry in Occupational and Environmental Health Practice. CRC Press, Boca Raton FL, pp 85-87, 1983.
3. Scriver C.A. et al The Metabolic Basis of Inherited Disease, 6th ed. McGraw-Hill, New York NY, pp 2349-50 on PFK deficiency. 1989.
4. Westerhof P. et al. Antimony leaching from polyethelene trephthalate (PET) plastic used for bottled drinking water. Water Res(2008)42:51-56.
5. Andra, SS et al. Co-leaching of brominated comounds and antimony from bottled

BISMUTH HIGH

This individual's urine bismuth (Bi) markedly exceeds the expected level. Urine is the major excretion mode for Bi, and this high level reflects a high level of exposure to the element. However, toxicity of Bi is slight and manifestations occur only when gram quantities are assimilated.

Bismuth is a byproduct of lead and copper ore refining. Bismuth has therapeutic uses with antimicrobial, anti-secretory and anti-inflammatory actions. Bismuth subsalicylate ("Pepto-Bismol") hydrolyzes in the stomach to salicylic acid and insoluble Bi; it can be effective in halting traveler's diarrhea. Historically, Bi was used to treat syphilis. Bismuth is used commercially in low-melting-point alloys and solders and is commonly in automatic sprinkler heads for building fire protection. Bismuth often is a component of: pigments, paints, glazes for ceramics, glass, and some semiconductor materials. Some cosmetics including lipstick may contain Bi oxides as a pigment (pearlescent white). Dry cell battery electrodes (cathode) may contain bismuth.

Early signs of excessive Bi exposure include: constipation or bowel irregularity, foul breath, skin pigmentation changes, and gum pigmentation (blue-black) with stomatitis. With excessive exposure and net retention, pathological changes may occur: erythema and skin sores, irritation of mucous membranes, nephritis, nephrosis with proteinuria and degeneration of proximal tubules, hepatitis with jaundice with fatty changes in the liver, and "bismuth encephalophy" with mental confusion, clumsiness, myoclonic jerks, tremors, and dysarthria. These acute symptoms are expected only with repeated ingestion of high doses (gram amounts) of soluble bismuth compounds.

Laboratory tests that help to assess Bi exposure are whole blood and hair element analyses. Some increase in urine Bi may follow administration of dithiol metal binding agents (DMPS, DMSA) as Bi has a very high propensity to bind to sulfhydryl groups.

BIBLIOGRAPHY FOR BISMUTH
1. Harrison's Principles of Internal Medicine, 13th ed, McGraw Hill, New York, NY pp. 282, 534, 1994.
2. Tsalev D.L. and Z.K. Zaprianov Atomic Absorption Spectrometry in Occupational and

Environmental Health Practice CRC Press, Boca Raton FL, pp 101-103, 1983.
3. Carson B.L. et al. Toxicology and Biological Monitoring of Metals in Humans Lewis Publishers, Chelsea MI pp 44-7, 1987.

LEAD HIGH

This individual's urine lead (Pb) is higher than expected which means that Pb exposure is higher than that of the general population. A percentage of assimilated Pb is excreted in urine. Therefore the urine Pb level reflects recent or ongoing exposure to Pb and the degree of excretion or endogenous detoxification processes.

Sources of Pb include: old lead-based paints, batteries, industrial smelting and alloying, some types of solders, Ayruvedic herbs, some toys and products from China and Mexico, glazes on(foreign) ceramics, leaded (anti-knock compound) fuels, bullets and fishing sinkers, artist paints with Pb pigments, and leaded joints in municipal water systems. Most Pb contamination occurs via oral ingestion of contaminated food or water or by children mouthing or eating Pb-containing substances. The degree of absorption of oral Pb depends upon stomach contents (empty stomach increases uptake) and upon the essential element intake and Pb status. Deficiency of zinc, calcium or iron increases Pb uptake. Transdermal exposure is significant for Pb-acetate (hair blackening products). Inhalation has decreased significantly with almost universal use of non-leaded automobile fuel.

Lead accumulates in extensively in bone and can inhibit formation of heme and hemoglobin in erythroid precursor cells. Bone Pb is released to soft tissues with bone remodeling that can be accelerated with growth, menopausal hormonal changes, osteoporosis, or skeletal injury. Low levels of Pb may cause impaired vitamin D metabolism, decreased nerve conduction,and developmental problems for children including: decreased IQ, hearing impairment, delayed growth, behavior disorders, and decreased glomerular function. Transplacental transfer of Pb to the fetus can occur at very low Pb concentrations in the body. At relatively low levels, Pb can participate in synergistic toxicity with other toxic elements (e.g. cadmium, mercury).

Excessive Pb exposure can be assessed by comparing urine Pb levels before and after provocation with Ca-EDTA (iv) or oral DMSA. Urine Pb is higher post-provocation to some extent in almost everyone. Whole blood analysis reflects only recent ongoing exposure and does not correlate well with total body retention of Pb. However, elevated blood Pb is the standard of care for diagnosis of Pb poisoning (toxicity).

BIBLIOGRAPHY FOR LEAD

1.ATSDR Toxicological Profile for Lead (2007 update) www.atsdr.cdc.gov/toxprofile
2. Centers for Disease Control and Prevention. Third National Report on Human Exposure to Environmental Chemicals. Atlanta, GA: CDC; 2005.
http://www.cdc.gov/exposure report/report.htm [Accessed 02/01/2009]
3. Lead Tech '92, "Proceedings and Papers from the Lead Tech '92: Solutions for a Nation at Risk" Conference, Sept 30-Oct 2, 1992. Bethesda, MD, IAQ Publications, 4520 East-West Highway, Ste 610, Bethesda, MD, 20814.
4. "Preventing Lead Poisoning in Young Children", US Centers for Disease Control, Atlanta, GA, Oct. 1991 Statement, US Dept. of Health and Human Services.
5. Carson B.L. et al. Toxicology and Biological Monitoring of Metals in Humans, Lewis Publishers, Inc.,

Chelsea, MI, p. 128-135, 1986.
6. Tsalev D.L. et al. Atomic Absorption Spectrometry in Occupational and Environmental Health Practice Vol 1, CRC Press, Boca Raton, FL 1983.
7. Piomelli S. et al. "Management of Childhood Lead Poisoning", J. Pediatr 105 (1990) p. 523-32.
8. Shubert J. et al. "Combined Effects in Toxicology - a Rapid Systematic Testing Procedure: Cadmium, Mercury and Lead" - J. Toxicology and Environmental Health, 4:763-776, 1978.
9. Mayo Clinic. Mayo Medical Laboratories. http://www.mayomedicallaboratories.com/test-catalog/clinical+and+Interpretive/60246 [Accessed 10/25/2011]
10. Saper RB et al. "Lead, mercury and arsenic in U.S. and Indian manufactured ayrevedic medicines sold via the internet." JAMA (2008) 300(8): 915-23.

MERCURY HIGH

This individual's urine mercury (Hg) is higher than expected but may not be sufficiently high to be associated with overt pathophysiological effects. Symptomatology depends on many factors: the chemical form of Hg, its accumulation in specific tissues, presence of other toxicants, presence of disease that depletes glutathione or inactivates lymphocytes or is immunosuppressive, and the concentration of protective nutrients, (e.g. zinc, selenium).

Early signs of excessive Hg exposure include: decreased senses of touch, hearing, vision and taste,metallic taste in mouth, fatigue or lack of physical endurance, and increased salivation. Symptoms may progress with moderate or chronic exposure to include: anorexia, numbness and paresthesias, headaches,hypertension, irritability and excitability, and immune suppression/dysregulation. Advanced disease processes from excessive Hg assimilation include: tremors and incoordination, anemia, psychoses, manic behaviors, possibly autoimmune disorders and renal dysfunction or failure. Note that in Hg exposure of long duration, renal excretion of Hg (and normal metabolites) may become impaired, and the urine level of Hg might be only mildly elevated or not elevated at all due to renal failure.

Mercury is used in: dental amalgams (50% by weight), explosive detonators; some vaccines, pure liquid form in thermometers, barometers, and laboratory equipment; batteries and electrodes, some medications and Ayurveic herbs, fungicides and pesticides, and in the paper industry. The fungicide/pesticide use of mercury has declined due to environmental concerns, but Hg residues persist in the environment. Emissions from coalfired power plants and hospital/municipal incinerators are significant sources of mercury pollution.

Methylmercury, the most common, organic form of Hg, occurs by methylation of inorganic Hg in aquatic biota or sediments (both freshwater and ocean sediments). Methylmercury accumulates in aquatic animals and fish and is concentrated up the food chain reaching highest concentrations in large fish and predatory birds. Except for fish, the human intake of dietary mercury is negligible unless the food is contaminated with one of the previously listed forms/sources. Daily ingestion of fish can result in the assimilation of 1 to 10 micrograms of mercury/day.

Depending upon theextent of cumulative Hg exposure, elevated levels of urine Hg may occur after administration of DMPS, DMSA or D-penicillamine. Blood and especially red blood cell elemental analyses are useful for assessing recent or ongoing exposure to organic (methyl) Hg.

BIBLIOGRAPHY FOR MERCURY

1.Centers for Disease Control and Prevention. Third National Report on Human Exposure

to Environmental Chemicals. Atlanta, GA: CDC; 2005.
http://www.cdc.gov/exposurereport/report.htm [Accessed 2/01/2009]
2. Suzuki T. et al eds, Advances in Mercury Toxicology, Plenum Press, New York, 1991.
3. World Health Organization: "Methylmercury" Environ. Health Criteria 101 (1990); "Inorganic Mercury" Environ. Health Criteria 118 (1991) WHO, Geneva, Switzerland.
4. Tsalev D.L. and Z.K. Zaprianov, Atomic Absorption Spectrometry in Occupational and Environmental Health Practice, CRC Press, Boca Raton FL, pp 158-69, 1983.
5. Birke G. et al "Studies on Humans Exposed to Methyl Mercury Through Fish Consumption", Arch Environ Health 25, 1972 pp 77-91.
6. Pelletier L. "Autoreactive T Cells in Mercury-Induced Autoimmunity", J. Immunology, 140 no.3 (1988) pp 750-54.
7. Werbach M.R. Nutritional Influences on Illness, 2nd ed, Third Line Press, Tarzana CA, pp 249, 647, 679, 1993.
8. Saper RB et al. "Lead, mercury and arsenic in U.S. and Indian manufactured ayurvedic medicines sold via the internet." JAMA(2008)300(8):915-23.

TIN HIGH

Tin is elevated in this individual's urine, and urine accounts for at least 80% of excreted tin that is ingested and absorbed from the gastrointestinal tract. Ingested tin is not significantly absorbed if it is an inorganic form. Oxide coatings readily form on metallic tin, and salts can quickly oxidize making them insoluble. Organic tin, however, is bioavailable and more readily absorbed. Some organic tin compounds such as short-chain alkyltins can be absorbed transdermally and can cause degeneration of myelin.

Food and drink usually provide small daily intakes of (nontoxic) tin, with amounts depending upon type of food, packaging, quality of drinking water and water piping materials. Total daily intake is expected to vary from about 0.1 to 15 milligrams. Tin is present in many metal alloys and solders; bronze, brass and pewter contain the element. Dyes, pigments and bleaching agents often contain tin. Anticorrosion plating of steel and electrical components may also use tin. "Tin cans" are tin-plated steel with a thin outer oxide layer allowing the surface to be shiny but inert. Modern food-containing cans usually have polymer coatings that prevent food-metal contact. In the past some toothpastes contained stannous fluoride, a soluble fluoride source for strengthening tooth enamel. Currently most brands of fluoridated toothpastes contain sodium fluoride. Organic tins, the usually toxic forms, are: biocides (triphenyltin and alkyltins) used against rodents, fungi, insects and mites; curing agents for rubbers and silicones (dialkyltin); and methyltin formed bacteriologically (similar to methylmercury).

Mildly elevated levels of tin in urine may reflect sporadic dietary intake and excretion; there may be no associated symptoms. A two- or three-fold increase in urine tin levels is not uncommon following administration of EDTA or with sulfhydryl agents (DMSA, D-penicillamine, DMPS). Early signs of chronic organic tin excess can be: reduced sense of smell, headaches, fatigue and muscle aches, ataxia and vertigo. Hyperglycemia and glucosuria are reported. Also, for organic tin exposure, there can be irritation of contacted tissues (eyes, skin, bronchial tubes, or GI tract). Later, immune dysfunction may occur with reduced lymphocytes and leukocytes; mild anemia may occur. A hair element analysis can be used to corroborate tin excess. Tin is commonly elevated in urine from autistic patients following administration of DMSA or DMPS.

BIBLIOGRAPHY FOR TIN

1. Winship K.A. ”Toxicity of Tin and Its Compounds”, Adverse Drug Reactions and Acute Poisoning Reviews, 7 no.1, pp 19-38, 1988.
2. Gray B.H. et al. ”Inhibition of Tributyltin Mediated Hemolysis by Mercapto Compounds” J. Applied Toxicology 6 no.5 pp 363-70, 1986. Discussed BAL, DMSA, DMPS relative effectiveness in inhibiting a toxic effect of tin.
3. Ganguly B.B. et al ”Cytotoxicity of Tin in Human Peripheral Lymphocytes in Vitro” Mutation Research, 282 no.2, pp 61-67, 1992.
4. Tsalev D.L. and Z.K. Zaprianov, Atomic Absorption Spectrometry in Occupational and Environmental Health Practice, vol. 2, CRC Press, Boca Raton, FL, pp 199-204, 1983.
5. Carson B.L. et al. Toxicology and Biological Monitoring of Metals in Humans, Lewis Publ., Chelsea MI, pp 260-63, 1987.

ZINC HIGH

High urinary zinc may or may not correspond to global zinc excess or to zinc loss from body tissues, because the major route for zinc excretion is via the bile, intestinal transport and feces. Typically, from two to ten percent of total zinc excretion occurs via urine; a similar amount occurs in sweat; the remainder (about 80 to 95%) occurs via biliary secretion to the intestine and is excreted in feces. Urine levels may fluctuate without reflecting or influencing body stores.

Very high urinary zinc levels are expected to result from EDTA detoxification therapy; 3 to 20 mg/L is commonly measured in the 12 hours following intravenous administration of EDTA. Lesser elevations of urine zinc also are expected to result from sulfhydryl agent detoxification therapy (DMPS, DMSA, D-penicillamine). One to five mg/L is commonly found in the 24 hours following administration of these agents. Zinc repletion may be beneficial or required during such therapies.

Breakdown of tissue releases zinc into extracellular fluids and increases urinary zinc levels. This may be observed following or in conjunction with: accidental injury, surgery, catabolism of diseased/disordered tissue, starvation (ketosis) and diabetes. Zinc wasting may occur in alcoholic cirrhosis.

Zinc overload or toxicity can occur from ingestion of zinc contaminated food or drink; galvanized pipes or pails can be sources. Occupational or environmental exposure to zinc fumes may produce an acute contamination or poisoning. Elevated urinary zinc beyond two standard deviations high (without provocation) warrants investigation of possible sources of zinc excess, or of tissue catabolism or injury.

Excessive amounts of zinc in body tissues may displace copper and/or iron from tissue binding sites and may provoke anemia. Symptoms consistent with chronic zinc toxicity include: lethargy, difficulty writing and with fine motor skills, light-headedness, and renal failure. Immediate symptoms (within 12 hours) of acute zinc excess via ingestion include: nausea, vomiting, diarrhea, exhaustion, headache, dizziness, and myalgia. Other laboratory findings consistent with zinc toxicity would be: elevated leukocyte count, elevated serum amylase and lipase, elevated whole blood zinc concentration, elevated hair zinc level (if the zinc excess is chronic).

BIBLIOGRAPHY FOR ZINC

1. Lantzsch H.J. and H. Schenkel ”Effect of Specific Nutrient Toxicities in Animals in Animals and Man: Zinc in Handbook Series in Nutrition and Food, Sect.E, vol 1, CRC Press, Boca Raton FL, pp 291-307, 1978.

2. King J.C. and C.I. Keen ”Zinc” Chapt. 10 in Modern Nutrition in Health and Disease 8th ed. Shils, Olson and Shike eds, Lea & Febiger, Philadelphia PA, pp 214-230, 1994
3. Tsalev D.L. and Z.K. Zaprianov Atomic Absorption Spectrometry in Occupational and Environmental Health Practice vol 1, CRC Press, Boca Raton FL, pp 209-14, 1983.
4. Aggett P.J. ”An Overview of the Physiology and Metabolic Role of Zinc” in Zinc in Human Medicine, Inst. Child Health, London, TIL Publications, Toronto, Ont. pp 9-38, 1984.
5. Fell G.S. ”Diagnosis of Zinc Deficiency” in Zinc in Human Medi- cine ibid. pp 39-50.
6. Petering, H.G. ”Some Observations on the Interaction of Zinc, Copper and iron Metabolism in Lead and Cadmium Toxicity.” Environ. Health Perspect., pp. 141-145, 1978.
7. Lauwerys, R. et al. ”The Influence of Orally-Administered Vitamin C or Zinc on the Absorption of and Biological Response to Lead.” J. Occup. Health, 25: pp. 668-678, 1983.

COPPER HIGH

Significantly elevated copper in urine can be secondary to provocative challenge with sulfhydryl (-SH) bearing agents such as D-penicillamine (”Cuprimine”), DMSA, or DMPS. Large, multi-gram doses of vitamin C (ascorbic acid), administered orally or intravenously, may slightly or moderately increase excretion of copper.

Increased urinary copper can be an artifact of nutritional supplementation with copper or come from drinking water that is high in copper content. Acidic water carried in copper pipes can dissolve some copper which increases the copper intake if used for drinking or cooking. Molybdenum supplementation at high levels or if inappropriate may cause increased copper excretion; molybdenum and copper are mutually antagonistic in terms of body retention.

Bacterial or other infections may cause hypercupremia with attendant or delayed hypercuprinuria. This is transient and follows the inflammatory stage of the disease. Published studies such as Vivoli, Sci Total Environ, 66 p. 55-64, 1987 have correlated increased urinary copper with increased blood pressures in hypertensives. Biliary obstruction or insufficiency can decrease normal excretion of copper via the bile while increasing blood and urinary levels. Proteinuria also may feature increased copper levels.

Hyperaminoacidurias that include histidinuria can result in urinary copper wasting because histidine is a powerful chelator of copper. Hyperaminoacidurias that include histidine can be of many origins including:genetic factors, chemical or elemental toxicities, infectious agents, hyperthyroidism, sugar intolerances,nephrotic syndromes, etc.

In Wilson’s disease, urinary copper is generally increased (above 100 micrograms/24 hours) without provocation or chelation. Use of D-penicillamine or DMPS as a provocative diagnostic procedure can yield a 5 - 10X increase in urinary copper levels in normal individuals. In contrast, Wilson’s disease patients may then excrete 50-100 times the normal levels or 1000 to 2000 mcg/24 hr. (Walshe, J. Rheumatology (supp/7) 8 p.3-8, 1981).

Urine analysis (unprovoked) is not an adequate procedure to assess copper stores or copper metabolism. Blood levels, erythrocyte copper content, erythrocyte superoxide dismutase activity, and serum ceruloplasmin are other more indicative measurements for copper status.

BIBLIOGRAPHY FOR COPPER

1. Braunwald et al., eds. Harrison’s Principles of Internal Medicine, 11th ed., McGraw Hill,

Chapter 311,1987.
2. Johnson M.A. and B.E. Kays, "Copper:Its Role in Human Nutrition", Nutrition Today, Jan/Feb 1990,pp 6-14.
3. Harper et al. Review of Physiological Chemistry, Lange Medical Publications, 17th ed., pp. 588-89, 1979.
4. J. M. Walshe "The Discovery of the Therapeutic use of D-Penicillamine" J. Rheumatology (Supplement 7) 8, pp. 3-8, 1981.
5. Werbach M.R. Nutritional Influences on Illness 2nd ed., Third Line Press, Tarzana, CA, 1993.
Multiple source references on copper physiology and pathology.

CHROMIUM LOW

The chromium level in this urine sample is low. Chromium (Cr) is essential for proper metabolism of glucose in humans. It potentiates the action of insulin via glucose tolerance factor (GTF) which is Cr+3 bound in a dinicotinic acid-glutathione complex. Other functions of Cr include aiding in lipid metabolism and assisting with HDL/LDL cholesterol balance.

Significance of Low Chromium: Clinical findings consistent with Cr deficiency are those of GTF insufficiency including diabetes, hyperglycemia, and possibly transient hyper/hypoglycemia. Excessive LDL cholesterol also may be consistent with Cr deficiency. Some investigators have linked Cr deficiency to ischemic heart disease and atherosclerosis.

Other Useful Analyses: Urine Toxic Metals and Essential Elements provocative testing with EDTA can be used to assess Cr stores.

BIBLIOGRAPHY FOR CHROMIUM LOW

1. Anderson R.A. Essentiality of Chromium in Humans" Sci Total Environ. 86, 1989, pp 75-81.

2. Anderson R.A. et al, Am. J. Clin. Nutr. 41, 1985 pp 571-77

3. Mertz W., "Chromium Occurrence and Function in Biological Systems". Physiological Review 49(2), 1969, pp 163-239.

4. Mertz, W. Clinical, Biochemical and Nutritional Aspects of Trace Elements, Alan R. Liss, Inc., New York, NY, 1982, pp 315-23.

5. Rennert O.M. and W-Y Chan Metabolism of Trace Metals in Man vol II, CRC Press, Boca Raton FL, pp 122-24.

6. Tsalev D.L. and Z.K. Zaprianov, Atomic Absorption Spectrometry in Occupational and Environmental Health Practice, CRC Press, Boca Raton, FL, 1983, pp 113-17.

7. Wallach S.J. Am. Coll. Nutr 4, 1985, pp 107-120

LITHIUM HIGH

The concentration of lithium (Li) in this urine specimen is unexpectedly high. Li occurs almost universally at low concentrations in water and in plant and animal food products. Li has important functions in the nervous system, and possibly the immune system. Assimilation of Li from food, water and even commonly available organic Li supplements (when taken as directed) would not be expected to be associated with abnormally high levels of Li in urine. In contrast, much higher doses of inorganic Li carbonate, which are often prescribed for specific mood disorders, would be expected to be associated with markedly elevated urine Li if ingestion was recent or chronic.

Occupational/accidental assimilation of excessive amounts of Li could possibly be associated with the manufacture or improper handling of lightweight metal alloys, glass, lubrication greases, and batteries.

Li, when assimilated in excessive quantities, may cause dermatitis, nausea, confusion, course hand tremor, slurred speech, edema, or hypotension. Li toxicity may be more pronounced with low sodium intake. Point-in-time Li doses/exposure are rapidly excreted in urine, and blood analysis may not be indicative of exposure after 5 to 7 days.

SELENIUM LOW

Urine accounts for about one-half of the total body excretion of dietary selenium when normal amounts are ingested. Seafood, organ meats, cereal grains, and seleniferous vegetables (garlic, onions) are good dietary sources. Selenium is also excreted in sweat, and lesser amounts are present in fecal matter. Because diets are highly variable in selenium content, urine is not a reliable indicator of selenium adequacy or function.

Low urinary selenium may be a consequence of: junk food diet or highly-processed food diet, gastrointestinal dysfunctions, renal insufficiency (in which case other elements will be subnormal in urine but possibly elevated in blood), and long-term parenteral nutrition or special diets that are low in selenium.

Selenium is a necessary element for proper activity of two enzymes in human metabolism: glutathione peroxidase (GPx) and iodothyronine deiodinase (ITD). Selenium deficiency may cause weakness or rate limitation for one or both of these enzymes. GPx oxidizes glutathione while reducing oxidized lipids. Weak GPx activity may allow excessive inflammation to occur. ITD deiodinates thyroxine prohormone and catalyzes T4 _ T3. Selenium deficiency may be a cause of insufficient T3 and thyroid dysfunction (Berry J.M. Nature 349, 1991 pp.438-40).

Symptoms consistent with selenium deficiency include: myalgia, increased inflammatory responses, hypothyroidism with low T3. Cardiomyopathy and Keshan disease can occur in cases of severe, chronic Se deficiency. Subnormal selenium may accentuate the effects of cadmium, mercury or arsenic overload. Confirmatory tests for selenium status include packed red blood cell elements, and hair elemental analysis (provided that antidandruff shampoos have not been used.

BIBLIOGRAPHY FOR SELENIUM

1. Berry M.J. et al. ”Type I Iodothyronine Deiodinase is a Selenocysteine-Containing Enzyme”

Nature 349 (1991) pp 438-40.
2. Oldfield J.E. ”Some Implications of Selenium for Human Health” Nutrition Today (Jul/Aug 1991) pp 6-11.
3. Levander O.A. and R.F.Burk ”Selenium” Chapt. 12 in Modern Nutrition in Health and Disease 8th ed. Shils, Olson and Shike eds. Lea & Febiger, Phila. PA, pp 242-51, 1994.
4. Martin J.L. ”Nutrient Toxicities in Animals and Man: Selenium” in Handbook Series in Nutrition and Food Sect. E, Vol I, CRC Press Boca Raton FL, pp 309-18, 1978.
5. Tsalev D.L. and Z.K. Zaprianov Atomic Absorption Spectrometry in Occupational and Environmental Health Practice CRC Press, Boca Raton FL, pp 182-87, 1983.