The Great Plains Laboratory, Inc.

LAB#:
PATIENT:
SEX:
DOB: AGE:
CLIENT#:

# *Toxic & Essential Elements; Packed Red Blood Cells*

| ESSENTIAL AND OTHER ELEMENTS | | RESULT / UNIT | REFERENCE INTERVAL | PERCENTILE 2.5th 16th 50th 84th 97.5th |
|---|---|---|---|---|
| Calcium | (Ca) | **13** µg/g | 8-26 | |
| Magnesium | (Mg) | **46** µg/g | 39-59 | |
| Potassium | (K) | **88** mEq/L | 78-97 | |
| Phosphorus | (P) | **601** µg/g | 520-670 | |
| Copper | (Cu) | **0.694** µg/g | 0.52-0.8 | |
| Zinc | (Zn) | **11.7** µg/g | 7.8-13.8 | |
| Iron | (Fe) | **880** µg/g | 800-1010 | |
| Manganese | (Mn) | **0.041** µg/g | 0.009-0.033 | |
| Selenium | (Se) | **0.193** µg/g | 0.16-0.49 | |
| Boron | (B) | **0.068** µg/g | 0.01-0.11 | |
| Molybdenum | (Mo) | **0.0003** µg/g | 0.0002-0.001 | |

| TOXIC METALS | | RESULT / UNIT | REFERENCE INTERVAL | PERCENTILE 95th 99th |
|---|---|---|---|---|
| Arsenic | (As) | **0.0125** µg/g | < 0.008 | |
| Cadmium | (Cd) | **0.0006** µg/g | < 0.002 | |
| Cesium | (Cs) | **0.0063** µg/g | < 0.015 | |
| Chromium | (Cr) | **0.0004** µg/g | < 0.0005 | |
| Lead | (Pb) | **0.010** µg/g | < 0.05 | |
| Mercury | (Hg) | **0.0076** µg/g | < 0.01 | |
| Thallium | (Tl) | **< 0.00004** µg/g | < 0.00005 | |



## SPECIMEN DATA

Comments:

Date Collected: **04/24/2017**
Date Received: **04/28/2017**
Date Reported: **04/29/2017**

Methodology: **ICP-MS**

PACKED BLOOD CELL ELEMENTS REPORT

INTRODUCTION

This analysis of elements in packed blood cells was performed by ICP-Mass Spectroscopy following acid digestion of the specimen in a closed microwave system. For a given element, these procedures measure the sum of the amounts of surface-adhering and intracellular content, regardless of chemical form. For units of measurement, mg/l is approximately equivalent to ppm, and mcg/l is approximately equivalent to ppb.

The packed cells are not washed, and therefore, a very small amount of residual plasma remains as part of the specimen. Washing would eliminate some important plasma membrane-bound elements. Because the cells are not washed, the DDI reference range may vary from published ranges for intracellular content of washed erythrocytes. Blood cell specimens that are not adequately centrifuged, per the kit instructions, may yield distorted or invalid results because of excess plasma content.

Packed blood cell analysis is intended to be a diagnostic method of assessing insufficiency or excess of elements that have important functions inside blood cells or on blood cell membranes. Additional testing of whole blood or serum/plasma or other body tissues may be necessary for differential diagnosis of imbalances. Additional testing also may be necessary to assess specific dysfunctions of assimilation, transport, retention, or excretion of elements. Packed blood cell element analysis is additionally intended to determine elevated or excessive levels of five potentially toxic elements that can accumulate in erythrocytes: antimony, arsenic, cadmium, lead, and mercury.



If an element is sufficiently abnormal per the blood cell measurement, a descriptive text is included with the report. For elements with essential or beneficial functions, a text will print if the measured result is below -1.5 standard deviations from the mean of the reference population, or if the result is above +1.5 standard deviations from the mean of the reference population. For potentially toxic elements, a text prints whenever the measured result exceeds the expected range. If no descriptive element texts follow this introductory discussion, then all essential cell elements were measured to be within +1.5 SD, and all measured potentially toxic elements were within expected ranges.

Doctor's Data states the reference range as +1 SD from the mean of the reference population. This is considered to be the nutritionally and physiologically optimal range for elements with essential or beneficial functions. Physiological imbalance corresponds to levels beyond +1 SD but pathological consequences are not expected until the blood level is beyond +2 SD. Element levels beyond +2 SD may only be temporary nutritional problems or they may reflect a failure of homeostasis to control blood quantities. Pathological consequences depend upon cell and tissue functions which are disrupted by such levels.

MANGANESE HIGH

Manganese (Mn) is required as an activator for several enzymes in humans including some that control entry of carbohydrate and protein metabolites into the tricarboxylic acid cycle so that oxidative phosphorylation can occur. Pyruvate decarboxylase is such an enzyme. Isocitrate

dehydrogenase (in the tricarboxylic acid cycle) and arginase (in the urea cycle) are also activated by manganese. The mitochondrial matrix form of the superoxide dismutase (SOD) enzyme requires Mn. Manganese is concentrated in mitochondria-rich tissue such as liver, kidney, pancreas and brain.

Erythrocyte Mn concentration normally is 10x to 20x that of serum. In erythrocytes, Mn+2 binds strongly to porphyrin (not a functional use of Mn). In other cells, Mn is active in the mitochondria, cell nucleus, and endoplasmic reticulum. The formation of Mn porphyrin in RBCs reflects accumulation of Mn in the body but does not necessarily indicate detrimental or toxic effects.

Non-municipal drinking water, especially water from private wells, can be a source of manganese that can moderately increase blood levels. Individuals on an extended course of therapeutic medication may present whole blood Mn up to 2x the upper limit of the expected range (DDI observation based on communications from attending physicians). In liver diseases, mitochondrial Mn (as in Mn-SOD) can be released into the blood stream. Elevated blood cell Mn may or may not result. Other clinical conditions associated with elevated blood cell Mn include biliary insufficiency, gallbladder diseases or biliary obstruction. Calcium deficiency is reported to enhance uptake and retention of Mn.



Documented symptoms and effects of elevated Mn include: fatigue, headache, low systolic blood pressure, drowsiness followed by insomnia, and sexual impotence. Deterioration of memory, asthenia, and tremor, clinical features similar to Parkinson's disease, may occur. Acute contamination or Mn poisoning may result in euphoria, hallucinations and inappropriate laughter ("manganese madness"). Mn is considered neurotoxic partly due to its interference with adrenal catecholamine metabolism; tetrahydrobiopterin levels are reduced causing reduced dopamine formation from tyrosine (Daniels and Abarca, Neurotoxicology and Teratology 13,1991,pp485-87).



Confirmatory tests for excessive manganese are (1) hair mineral analysis with hair Mn concentration exceeding about 2 ppm; (2) urine analysis featuring significantly elevated urine levels following oral challenge of D-penicillamine.

BIBLIOGRAPHY FOR BLOOD CELL MANGANESE, HIGH

1. Leach R.M. and M.S. Lilburn, "Manganese Metabolism and Its Function", World Reviews Nutr. Diet 32, Karger, Basel, Switzerland 1978pp 123-34.

2. Tsalev D.L. and Z.K. Zaprianov, Atomic Absorption Spectroscopy in Occupational and Environmental Health Practice vol 1, CRC Press,Boca Raton FL, 1983 pp 153-58.

3. Donaldson J. and A. Barbeau, "Manganese Neurotoxicity: Possible Clues to the Etiology of Human Brain Disorders", Metal Ions in Neurology and Psychiatry, Alan Liss Inc., New York, NY 1985 pp 259-85.

4. Kondakis X.G., et al, "Possible Health Effects of High Manganese Concentration in Drinking Water" Arch. Environ. Health 44 no.3,1989 pp 175-78.

5. Parenti M. et al, "Role of Dopamine in Manganese Neurotoxicity", Brain Research 473, 1988 pp 236-40.

6. Calne D.B. et al, ”Manganese and Idiopathic Parkinsonism: Similarities and Differences” Neurology 44 no.9, 1994 pp 1583-86.

7. Chin-Chang H. et al ”Chronic Manganese Intoxication”, Arch of Neurology 46, 1989 pp 1104-06.

## ARSENIC HIGH

Blood cell arsenic (As) exceeds the expected level for this individual. Usually, arsenic clears the blood rapidly after a point-in-time exposure. The finding of elevated blood cell As suggests: (1) recent exposure, (2) chronic or on-going exposure, (3) decreased metabolic capacity to clear As. Arsenic has two oxidation states or valences, As+3 and As+5. As+3 is more reactive and toxic. Both forms of As accumulate primarily in skin and skeletal tissue; also in liver, kidney and spleen. Over one-half of ingested or absorbed As is normally excreted via urine and feces in 2 to 8 days.

In blood cells, As binds primarily to globulin, but generally As seeks out thiols and sulfhydryl binding sites. The vitamin cofactor, lipoic acid, is particularly affected, and this may be the reason for inhibition of alpha-ketoacid oxidation. Much of the enzymatic inhibition caused by As occurs in cells with mitochondrial structures (not erythrocytes). Arsine gas, AsH3, does react rapidly with erythrocytes, combining with hemoglobin and causing hemolysis, hemoglobinuria and hematuria.



An important detoxication pathway for As involves methylation with methyl groups donated by S-adenosylmethionine; methylated arsenic can produce a garlic-like breath odor.

Early symptoms of arsenic excess include: fatigue, malaise, eczema or allergic-like dermatitis, and increased salivation. Increased body burden of arsenic can lead to further manifestations: skin hypopigmentation, white striae on fingernails, hair loss, stomatitis, peripheral neuropathy, myocardial damage, hemolysis, and anemia (aplastic with leukopenia).



Sources of arsenic include: contaminated foods (especially seafood), water or medications. Industrial sources are: ore smelting/refining/processing plants, galvanizing, etching and plating processes. Tailing from or river bottoms near gold mining areas (past or present) may contain arsenic. Insecticides, rodenticides and fungicides (Na-,K-arsenites, arsenates, also oxides are commercially available). Commercial arsenic products include: sodium arsenite, calcium arsenate, lead arsenate and ”Paris green” which is cupric acetoarsenite, a wood preservative. Elevated blood As of undetermined source is reported in hemodialysis patients.

Hair element analysis can be done for corroborative evidence of arsenic excess. Blood arsenic levels are not dose-related and may not accurately reflect As body burden. Urine analysis following provocation with D-penicillamine or DMSA can corroborate excess, but sequestered As may not show in early trials.

BIBLIOGRAPHY FOR BLOOD CELL ARSENIC

1. Carson B.L. et al. Toxicology and Biological Monitoring of Metals in Humans, Lewis Publishers, Chelsea, MI, 1987 pp 24-33.

2. Tsalev D.L. and Z.K. Zaprianov Atomic Absorption Spectrometry in Occupational and Environmental Health Practice, vol 1, CRC Press, Boca Raton, FL, 1983 pp 87-93.

3. Clarkson T.W. et al. eds. Biological Monitoring of Toxic Metals, Plenum Press, New York, NY, 1988 pp 309-15.

4. Harrison's Principles of Internal Medicine, 11th ed., McGraw Hill, New York, NY, 1987 pp 850.

5. Heyman A. et al. "Peripheral Neuropathy Caused by Arsenical Intoxication" New Eng. J. Med., 254, no. 9, 1956 pp 401-9.

6. DeKimpe J. et al, "More Than Tenfold Increase of Arsenic in Serum and Packed Cells of Chronic Hemodialysis Patients" Am. J. Nephrology 13, 1993 pp 429-34.