The Great Plains Laboratory, Inc.

Toxic Metals; urine

TOXIC METALS		RESULT µg/g Creat	REFERENCE INTERVAL	WITHIN REFERENCE / OUTSIDE REFERENCE
Aluminum	(Al)	1.2	< 25	
Antimony	(Sb)	0.046	< 0.18	
Arsenic	(As)	43	< 50	
Barium	(Ba)	3.2	< 5	
Beryllium	(Be)	<dl	< 0.10	
Bismuth	(Bi)	15	< 1	
Cadmium	(Cd)	0.13	< 0.9	
Cesium	(Cs)	4.4	< 10	
Gadolinium	(Gd)	<dl	< 0.8	
Lead	(Pb)	0.66	< 1.2	
Mercury	(Hg)	0.71	< 1.3	
Nickel	(Ni)	2.8	< 5	
Palladium	(Pd)	0.07	< 0.3	
Platinum	(Pt)	<dl	< 0.1	
Tellurium	(Te)	<dl	< 0.5	
Thallium	(Tl)	0.18	< 0.5	
Thorium	(Th)	<dl	< 0.02	
Tin	(Sn)	0.52	< 5	
Tungsten	(W)	<dl	< 0.4	
Uranium	(U)	0.021	< 0.03	

URINE CREATININE	RESULT mg/dL	REFERENCE INTERVAL	-2SD -1SD MEAN +1SD +2SD
Creatinine	119	30 – 225	

SPECIMEN DATA

Comments:
Date Collected: 09/03/2020
Date Received: 09/09/2020
Date Reported: 09/11/2020
Methodology: ICP-MS QQQ, Creatinine by Jaffe Reaction

Provocation: Post Provocative
Collection Period: Random
pH upon receipt: Acceptable

< dl: less than detection limit
Results are creatinine corrected to account for urine dilution variations. **Reference intervals are based upon NHANES (cdc.gov/nhanes) data if available, and are representative of a large population cohort under non-provoked conditions.** Chelation (provocation) agents can increase urinary excretion of metals/elements.

The Great Plains Laboratory, Inc.

Essential Elements; urine

ESSENTIAL ELEMENTS		RESULT mEq/g Creat	REFERENCE INTERVAL	PERCENTILE 2.5th 16th 50th 84th 97.5th
Sodium	(Na)	50.0	45 – 200	
Potassium	(K)	21.9	20 – 110	
		RESULT µg/mg Creat		
Phosphorus	(P)	573	180 – 1100	
Calcium	(Ca)	217	30 – 350	
Magnesium	(Mg)	118	25 – 230	
Zinc	(Zn)	0.79	0.1 – 1.5	
Copper	(Cu)	0.0066	0.006 – 0.026	
Sulfur	(S)	1040	250 – 1050	
Molybdenum	(Mo)	0.0089	0.013 – 0.13	
Boron	(B)	2.0	0.6 – 4	
Lithium	(Li)	0.0204	0.009 – 0.2	
Selenium	(Se)	0.162	0.03 – 0.25	
Strontium	(Sr)	0.332	0.045 – 0.3	

		RESULT µg/g Creat	REFERENCE INTERVAL	68th 95th
Cobalt	(Co)	1.1	< 1.7	
Iron	(Fe)	2	< 50	
Manganese	(Mn)	0.04	< 0.6	
Chromium	(Cr)	<dl	< 2	
Vanadium	(V)	0.17	< 0.8	

URINE CREATININE		RESULT mg/dL	REFERENCE INTERVAL	-2SD -1SD MEAN +1SD +2SD
Creatinine		119	30 – 225	

SPECIMEN DATA

Comments:
Date Collected: 09/03/2020
Date Received: 09/09/2020
Date Reported: 09/11/2020
Provocation: Post Provocative
Collection Period: Random
pH upon receipt: Acceptable
Methodology: ISE, Spectrophotometry, ICP-MS QQQ, Creatinine by Jaffe Reaction

< dl: less than detection limit
Results are creatinine corrected to account for urine dilution variations. **Reference intervals are based upon NHANES (cdc.gov/nhanes) data if available, and are representative of a large population cohort under non-provoked conditions.** Chelation (provocation) agents can increase urinary excretion of metals/elements.

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.

- 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.
- 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.

This analysis of urinary essential elements was performed by ICP-Mass Spectroscopy. Analysis of essential and other elements in urine is used primarily to identify and characterize renal wasting conditions. Analysis of essential elements in urine is not a direct approach for assessing nutritional status or adequacy. Blood, cell, and other assimilation and retention parameters are optimal direct indicators of essential element status.

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 24 hour urine collections essential elements are reported as mg/24 h. For timed or first morning urine collections, elements are normalized per gram creatinine to avoid the potentially great margin of error which can be introduced by variation in the sample volume (concentration). It should be noted that creatinine excretion for an individual may vary to some extent over the course of a day, and from day to day.

If an essential element is sufficiently abnormal per urine measurement, a descriptive text is included with the report. If there are no descriptive texts following this introduction, all essential element levels are within acceptable range. All reference ranges are age and sex specific.

This analysis of urinary toxic metals and essential elements was performed by ICP-Mass Spectroscopy. Analysis of metals in urine is traditionally used for evaluation of very recent or ongoing exposure to potentially toxic metals. The urinary excretion of certain metals is known to be increased (provoked) to a variable extent after administration of specific chelating agents. Reference values and corresponding graphs are representative of a healthy population under non-provoked conditions; reference values have not been established for provoked urine samples.

Analysis of essential and other elements in urine is used primarily to identify and characterize renal wasting conditions. Analysis of essential elements in urine is not a direct approach for assessing nutritional status or adequacy. Blood, cell, and other assimilation and retention parameters are optimal direct indicators of essential element status.

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 24 hour urine collections essential elements are reported as mg/24 h, and toxic metals are reported as µg/24 h. For timed, random or first morning urine collections, elements and metals are normalized per gram creatinine to avoid the potentially great margin of error that can be introduced by variation in the sample volume (concentration). It should be noted that creatinine excretion for an individual may vary to some extent over the course of a day, and from day to day.

If an essential element is sufficiently abnormal per urine measurement, a descriptive text is included with the report. For potentially toxic elements, a descriptive text is provided whenever levels are measured to be higher than the unprovoked reference values. If there are no descriptive texts following this introduction, all essential element levels are within acceptable range and all potentially toxic metals are at levels below the unprovoked reference values. All reference ranges and reference values are age and sex specific.

Bismuth High

This individual's urine bismuth is higher than expected. Urine is the principal mode for excretion of absorbed bismuth. This element is considered to be only slightly toxic with ingestion of gram quantities necessary before signs of toxicity occur. Only between 5 and 10% of orally ingested, soluble bismuth salts are absorbed into the blood.

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 bismuth; it can be effective in halting traveler's diarrhea. Historically, bismuth was used to treat syphilis. Bismuth is used commercially in low-melting-point alloys and solders and is commonly in "automatic" sprinkler heads for in-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 bismuth oxides as a pigment (pearlescent white). Dry cell battery electrodes (cathode) may contain bismuth.

At sub-gram quantities, no toxic effects are documented for bismuth. Also, the existence of health problems due to environmental pollution by bismuth is not documented (Tsalev p. 101, 1983). Early physiological signs of bismuth excess may include: constipation or bowel irregularity, foul breath, skin pigmentation changes, and gum pigmentation (blue-black) with stomatitis.

Laboratory tests that help to assess bismuth status are whole blood and hair element analyses. Some increase in urine bismuth may follow administration of dithiol chelators (DMPS,DMSA). Bismuth has a very high affinity for sulfhydryl groups.

Copper Low

Low urinary copper may or may not correspond to subnormal copper levels in body tissues, and other laboratory tests are more indicative of copper status. Such tests include measurement of: whole blood or blood cell copper, hair copper, erythrocyte superoxide dismutase activity, and serum ceruloplasmin.Because the major route of copper excretion is via bile and feces, urinary levels may fluctuate without reflecting or influencing body stores.

Lower than normal excretion of copper (and other elements) can occur in renal insufficiency; in which case blood levels may be normal or elevated. Inadequate levels of molybdenum or zinc allow increased retention of copper, and transient hypocuprinuria may occur during periods when copper stores are accumulating.

Low urinary copper may also correspond to copper deficiency of nutritional or gastrointestinal origins.The richest dietary sources of copper are: nuts, shellfish, liver, raisins and legumes. Dairy products generally are low in copper content. Gastric hypochlorhydria, sprue, and pancreatic dysfunction may inhibit copper uptake.

Molybdenum Low

This individual's molybdenum level is lower than one standard deviation below the mean of the reference population which means that this individual's urine molybdenum level corresponds to the lowest 17% (approximately) of that population.

Molybdenum is an essential activator of some important enzymes in the body: sulfite oxidase (catalyzes formation of sulfate from sulfite), xanthine oxidase (formation of uric acid and superoxide ion from xanthine), and aldehyde oxidase (processes aldehydes). Over 50% of absorbed Mo is normally excreted in urine; the remainder is excreted via bile to the feces or is excreted in sweat.

The level of molybdenum in urine may be a transient finding and may not reflect body tissue or liver levels. In copper deficiency, retention of molybdenum is increased (tissue levels could be normal or high), while urine levels might be subnormal. In renal insufficiency, molybdenum (and other elements) can be low in urine. Creatinine clearance and blood metabolite levels should be measured if a renal transport disorder is suspected.

Individuals receiving prolonged total parenteral nutrition ("TPN") may have low body tissue and urine levels of molybdenum because it is occasionally omitted from TPN formulations.

Molybdenum in foods is mostly in soluble complexes, and only a small amount is required daily (100 to 200 micrograms, adults). Therefore, frank molybdenum deficiency is uncommon. However, GI dysfunctions, poor-quality diet, and stressors can combine to produce inadequate molybdenum. Tungsten is a powerful antagonist of molybdenum retention, copper less so. Episodic exposures to high levels of either may result in periods of low Mo excretion that follow prior periods of high Mo excretion. Sulfites, aldehydes and high amounts of purines in the diet may increase need for and retention of molybdenum. Prolonged use of dithiol chelators (DMPS,DMSA) or MSM can result in poor molybdenum status as indicated by low levels in red blood cells(DDI observations).

A multielement hair analysis plus analyses for serum and urine uric acid can be used to confirm or rule out molybdenum insufficiency.

Potassium Low

The level of potassium (K) is lower than expected in this sample. K is an electrolyte and a potentiator of enzyme functions in cells. K can be low in the body as the result of gastrointestinal or renal dysfunction, or as a side effect of some diuretics. In adrenocortical hyperactivity, blood levels of K are depressed, while urinary K is increased. Diabetic acidosis and other medical conditions may result in severe K loss. Symptoms of true K deficiency include: muscle weakness, fatigue, and tachycardia. An electrocardiogram may show abnormalities when K is low in serum/plasma or whole blood.

Appropriate tests to confirm low K in body tissues may include measurements of packed red blood cell K; serum or whole blood K and sodium/K ratio.

Selenium High

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. However, selenium excess or overload can feature high urinary levels. Without occupational or environmental exposure, or excessive dietary intake, urinary selenium is expected to be below 100 micrograms per liter.

Selenium can be toxic with long-term intake as low as 750 mcg/day. Essential daily selenium requirements range from 10 micrograms (infants) to 50-70 micrograms (adults). Some manifestations of chronic selenium exposure are: fatigue, jaundice, hyperpigmentation of skin, unstable blood pressure, reddish discoloration and structural degeneration of nails and teeth, and dizziness. A garlic-like breath odor usually occurs and there may be a metallic taste in the mouth. Acute selenium contamination generally occurs from inhalation of selenium fumes which inflame mucous membranes and cause coughing and irritation of eyes and nasal passages.

Packed red blood cell elements analysis is a more definite test for selenium status. Hair analysis may provide confirmation of selenium excess if exogenous sources of contamination(antidandruff shampoos) are eliminated.

Sodium Low

The concentration of sodium in this urine sample is lower than expected and is more than two standard deviations below the mean. Low urine sodium levels are uncommon but may be seen, for example, with severe vomiting and/or diarrhea. Further, a low urine sodium concentration implies that the kidney's capacity to reabsorb sodium must be intact and that some stimulus to conserve sodium is present. Urine sodium can vary from day to day depending on the degree of water reabsorption. To get an accurate assessment of renal clearance of sodium, both urine and serum sodium can be compared - this can be done with the fractional excretion of sodium (FENa) calculation (1).

Most of the sodium in the human body can be found either in blood or lymphatic fluid. Sodium levels are regulated by aldosterone (from the adrenal cortex) which acts on the proximal tubules of the nephron to increase reabsorption of sodium and water and to increase the excretion of potassium. Urine sodium testing has a role in the assessment of sodium concentration in the extracellular fluid (ECF) - urine sodium test results should be correlated clinically with sodium and water intake, observation for clinical signs of ECF volume contraction or expansion, serum sodium levels, estimation of renal function and GFR as well as with urine osmolality.

In a normal individual, urine sodium excretion generally reflects dietary intake - the less one ingests (e.g. low salt diet, etc.) the less one excretes. In dehydration (e.g. vomiting, diarrhea, etc.) sodium may be retained (less sodium output in urine) in efforts to retain water. Decreased urine sodium concentration also may be associated with disease states such as Conn's syndrome (primary hyperaldosteronism due to an aldosterone-producing adenoma), congestive heart failure, liver disease and/or nephrotic syndrome. Low urine sodium has been associated with greater risk of myocardial infarction in males with high blood pressure (2).

Strontium High

The primary use of Strontium (Sr) has been in the production of glass for color television cathode ray tubes (to block x-ray emissions) and in the production of metal alloys (e.g.aluminum, magnesium). The stable form of Sr is not known to pose any health threat. The prescription drug Strontium Ranelate is used in many countries (but not Canada or the USA) to increase bone density and reduce the occurrence of fractures. The isotope 90Sr (found in nuclear fallout) can lead to bone disorders, including bone cancer. The isotope 89Sr is a beta emitter used for palliation of pain in patients with metastatic bone cancer - after intravenous administration, up to 80% of the isotope is eliminated in urine (1).

Urine Sr levels provides useful information in the biological monitoring of the presence of this element in individuals therapeutically or environmentally exposed to Sr.