

Metal Exposure – What do I order and how do I interpret lab reports?

With increasing concerns about occupational or environmental metal exposure, patients are asking to be tested to see if they are at risk of adverse health effects. You order a blood test and the result comes back “high”. Now what do you do? Do you recommend chelation therapy? Benefit of chelation will not outweigh harm if the metal level is in a safe range.

The first challenge that you have is the reference range. Hospitals-In-Common Laboratory give a “normal/therapeutic” range for nickel of 1.70-25.50 nmol/L urine. This is not a safety range. From a toxicity perspective, a standard safe level for soluble forms of nickel is anything below 1300 nmol/L urine. A value of 50 nmol/L is high relative to no exposure, but does not indicate that the patient is at risk of developing adverse health effects.

Hospitals-In-Common Laboratory in Toronto does the metal testing for provincial hospital labs in Atlantic Canada. Unless specifically marked for environmental or occupational exposure, the sample is processed through the “medical stream” which uses a non-exposed convenience sample of patients as the reference group. The occupational / environmental exposure stream provides results relative to standards on safe exposure ranges. Hospitals-In-Common Laboratory is looking into how to best provide physicians with the additional information on whether a “high” value is within safe limits or in the toxic range.

The nickel example raises a second challenge: are we doing the right test? Urine test for nickel looks for soluble forms. If the concern is nickel exposure from welding, we want insoluble nickel not soluble nickel. With a short half-life, testing the urine for nickel is not productive. Hence, there are no toxicity standards for insoluble nickel. Testing for manganese and copper is similarly not helpful. Trivalent chromium is essential for glucose metabolism. A low blood value is useful in showing a deficiency of chromium. Hexavalent chromium is the toxic form. Toxicity standards are based on urine testing. *Testing blood, hair and nails provides you with results that you cannot meaningfully interpret.* When assessing arsenic exposure, you want to look for inorganic arsenic. While there are special tests to distinguish inorganic from organic, unless specifically requested you get one that tests for both. As with chromium, you want to test urine not blood, hair or nails.

The third challenge is that of confounders. Organic arsenic is common in seafood. One needs to abstain from eating seafood prior to testing. Arsenic is also common in soil, ash (lots of it from days when we used coal to heat our houses) and cigarette smoke. Chromium can be common in deer and moose meat. It can be found in groundwater contamination, contaminated air from incinerators, and cigarette smoke. Collection containers and testing equipment can contain lead and mercury – giving spurious results for these metals. Testing for organic mercury (e.g., methylmercury) should generally be limited to the research context because of the requirement for special collection equipment.

A good reference is the “Occupational Medicine Forum” by Joseph Schwerha in JOEM Vol. 49 (11), November 2007. Physicians who would like a copy can send me an email and I will forward a PDF of the article. Dr. Christopher Martin was one of the responders. He hails from Newfoundland, is an occupational medicine specialist and professor at the University of West Virginia. He does a lot of international consulting in toxicology. The Commission uses him for guidance on testing and interpretation for chemicals and metals. Physicians needing assistance in evaluating a possible exposure can give me a call.

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“M” in “MD” Stands for “Mathematician”

In the spring 2009 newsletter, I had an article on interpreting lab reports for metal exposure. The article referenced an article in the Journal of Occupational and Environmental Medicine (Schwerha 2007). That article contained a chart with ACGIH’s BEI standard threshold values. These values are in the US metric system. So the challenge for the physician is to convert micro-mol (μmol) or nano-mol (nmol) to μg .

This article reviews the math using chromium as the example. If you would prefer someone else to do the math, call a WorkSafeNB Medical Advisor. We will be glad to help.

Chromium comes in two forms: trivalent, which is essential to glucose metabolism; and hexavalent, which can be toxic. In the home, it can be found in paints, dyes, printer inks, treated wood, cigarette smoke and venison. Testing for chromium is done using 24-hour urine collection – get the volume and creatinine as well.

In the example, urine volume was 1200 ml, creatinine was 16.3 mmol/day and chromium was 62.5 nmol/day. The BEI for chromium is $< 25 \mu\text{g/L}$ in the ACGIH book and $< 25 \mu\text{g/gm}$ creatinine in the Schwerha article. BEI stands for “Biological Exposure Index”. It is the biological equivalent of the environmental 8-hr TLV-TWA airborne exposure standard. The 8-hr TLV-TWA (Threshold Limit Value-Time Weighted Average) is average airborne concentration of a substance to which it is believed most workers can repeatedly be exposed over 8-hour day and 40-hour workweek without adverse health effects.

The 62.5 nmol/day value for chromium in 1.2 L of urine becomes 52.08 nmol/L. Conversion multipliers can be found at www.syddpath.stvincents.com/au/other/Conversions/-ConversionMasterF3.htm – “0.052”. Alternately, one can locate the molecular weight of chromium – $51.996 \text{ gm/mol} = 0.052 \mu\text{g/nmol}$. $52.08 \text{ nmol/L} \times 0.052 = 2.71 \mu\text{g/L}$, which is well below the BEI of $25 \mu\text{g/L}$. Unfortunately, the lab misled the physician and patient by flagging the value of 62.5 nmol/day as “H”.

To relate the chromium to gm of creatinine, some additional calculations are necessary. The 16.3 mmol/day value for creatinine becomes $13.58 \text{ mmol/L} = 13,580 \text{ nmol/L}$. Multiply this by 0.0113 to convert to $153 \text{ mg/dl} = 1.53 \text{ gm/L}$. Divide $2.71 \mu\text{g chromium /L}$ by $1.53 \text{ gm creatinine /L} = 1.77 \mu\text{g chromium per gm creatinine}$. This is well below the BEI standard of $25 \mu\text{g/gm creatinine}$.

Reference:

Schwerha, J. J. (2007). "How do you interpret these lab results based on the following case presentation?" J Occup Environ Med **49**(11): 1291-4.