Hair Testing for Mercury and Other Toxic Metals

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Blood and urine tests for mercury, arsenic, antimony, and lead are often normal in poisoned people. Hair tests are hard to interpret because one poison – mercury – affects how the body transports minerals. This leads to results in hair, urine, and blood that often do not reflect the body's inventory of each element.

Twenty-four-hour urine mercury levels in normal healthy factory workers in one study were 184 mcg with no chelating agent, and 793 mcg with 2 g DMSA po. Industrial hygiene improvements reduced these values to 78 and 257.1 These are 25 to 100 times higher than typically seen in clinical practice with patients who have the signs and symptoms of mercury toxicity and improve on chelation. This is not to say mercury levels never relate to disease. By a quirk of fate, I knew the subject who had the highest DMPS-chelated urine mercury level in a particular study – about 32 mcg/9h after 300 mg DMPS po.2 He has a significant psychiatric history.

Chelated and unchelated urine mercury measurements seldom demonstrate toxicity and do not rule it out. Some textbooks suggest challenge tests are useful,3 but licensing boards may not agree.4

Acute exposure to mercury results in high blood and urine levels for some months. Organic mercury partitions strongly into hair, inorganic and metallic mercury do not. Even in modest exposures to fish (methyl) mercury, hair levels are much higher than those typically seen in inorganic or metallic mercury poisoning. Organic mercury also partitions strongly into red blood cells and is not excreted in urine. So in acute, recent exposure, the amounts of hair, urine, RBC, and whole blood mercury are informative.5 This is irrelevant in chronic toxicity where blood, urine and hair levels are low; all the organic mercury has long since converted to the inorganic form. High levels still prevail in the brain and other organs – which are not amenable to sampling and have poorly understood kinetics.6

Mercury causes derangement of mineral transport, and this effect continues during chronic intoxication.7 Minerals are cofactors for biochemical processes. Without the proper amount of each, enzymes do not work in harmony, resulting in pathology and symptoms.

This derangement of mineral transport affects the composition of various tissues and materials that can be sampled and assayed. Too few elements are determined for easy recognition in blood. Urine and stool samples necessarily remain fairly normal in chronic toxicity, since over the long-term, body intake of

each element must equal body excretion; it is the level within the body that varies substantially. Hair may be economically analyzed for a larger number of elements, leading to recognizable patterns.

People's sensitivity to mercury varies. As with any toxin, there is a dosage range in which some people will be poisoned and others will not. This is discussed in standard textbooks: "Hypersensitivity: Hypersensitivity to mercury is often unrecognized." "Cases have been reported in which individuals sensitive to mercury have experienced systemic reactions as a result of dental fillings with amalgam."8 A hypersensitive individual will have mineral transport derangement even at low mercury levels.

I am far from the first person to notice a characteristic 'toxic' appearance to mercurial hair tests. Twenty years ago I heard about this from ACAM doctors and their patients. Many physicians intuitively recognize mineral transport derangement in a hair test and associate it with toxicity.9

I have developed a rote method by which anyone can recognize the characteristic mercurial derangement of mineral transport in a hair test.10 Some math and a few hours of study can replace years of clinical experience. It is also clear cut: something that satisfies the 'counting rules' is 'abnormal' in the standard sense – there is less than 1 chance in 40 it occurred by happenstance. Finer statistical distinctions can be drawn, if desired. In practice, most tests are either clearly normal or abnormal.

Mercury-induced mineral transport derangement is general and applies to all minerals. Toxic element results for a mercury-poisoned person can be misleading. Low mercury and high levels of other toxic elements in a patient who is, after all, toxic often leads to misdiagnosis.

Platinum and antimony cause a reduction in body magnesium while it rises to very high levels in hair.

Mercury moves about using the same mineral transport proteins that it affects. A mercury-toxic person's hair test usually has low mercury, and the other results bear the characteristic signature of mineral transport derange-ment.

In the absence of mercury-induced mineral transport derangement, the interpretation of a hair test is straightforward: high levels in a hair sample mean high levels in the body. Low levels of essential elements mean the patient is deficient.

All methods of chemical analysis have limited accuracy and precision. Contamination is always a possibility. These factors are important when deciding if someone is poisoned based on the measured level of a specific material. By

applying a statistical method to combine a large number of measurements into one probabilistic result, problems with accuracy and precision come out in the wash. Thus, a counting-rules positive test means 39 chances in 40 the patient has enough mercury to impair his biochemistry – without regard to whether the sample was contaminated, the reference ranges were not ideal, the patient was taking lithium carbonate and neglected to tell the doctor, etc.

The greatest source of perceived unreliability in hair tests is when a physician unfamiliar with hair testing uses it. Not appreciating mineral transport derangement, this physician will see a lot more highs and lows than the statistical ranges on the test suggest and will find that supplementing the low essential elements and avoiding the high ones doesn't help. He may conclude that hair tests generate random numbers. This is like telling all the patients whose blood counts show elevated MCV to go on a diet because their blood cells are fat, and then deciding blood counts are useless since dieting doesn't make the patients better.

Tests should have age and sex specific reference ranges. This means that for children (those under 18) few laboratories are suitable. This will not stop other labs from saying they are, but it is not so. Doctor's Data, Inc., Great Plains, Inc., Biomolmed in Poland, Gheos in Italy, and Rocky Mountain Analytical Laboratory in Canada do have pediatric ranges. There are more than a dozen laboratories worldwide that determine element levels in hair. Others may also have pediatric reference ranges but the user must verify this by comparing ranges to a lab they know does rather than relying on a sales pitch. Pediatric results plotted against adult or all age reference ranges will give a false positive counting-rules result.

The clinically relevant ratios of elements (e. g. the Na/K 'thyroid sign') do not vary much with age or sex.

Pregnancy and lactation affect hair test results and there are no appropriate reference ranges, typically resulting in false positives. Hair grown before or afterwards must be used.

When looking at a hair test, first look at, and 'count,' the essential and other elements to decide how likely it is that mineral transport is orderly. If it is clearly deranged, the patient has mercury and the rest of the results are of limited utility. If clearly orderly, then look at the toxics section. It can be taken at face value. When the results are in between, intuition and judgment are still required. Having the patient read a good description of mercury poisoning11 and apply a highlighter to it is often helpful.

I'll explain how to interpret a Doctor's Data, Great Plains, or Rocky Mountain Analytical hair test here.12 Doctors Data has two different hair tests. You want the one that has both a toxic and an essential elements section. It will be helpful if

you have one of those in front of you when reading the discussion of how to 'count' it.13

These tests have two sections with element names on the left and color bands on the right. The top section is toxic elements like arsenic, lead, and mercury. Ignore that at first. Look at the lower section, which is 'essential and other' elements: calcium, magnesium, sodium, potassium, zinc, copper, etc. Work with this part first. The DDI/GPL test has color bands that black bars extend into. The RMAL test colors the bars to show which zone they extend into, presents the 'count,' and discusses it on page three of the report.

- In the lower essential and other elements box, count the number of bars that reach to the red zone, even if they just barely touch it. If that is four or more, your test meets a counting rule and shows a high probability of mercury-deranged mineral transport.
- Then count all the bars that go from the middle white bit towards the right. If that's five or less, it meets a rule.
- Similarly, if the number of bars going LEFT is five or less.
- Then you count the number of bars that never make it to the yellow zone. If this number is 11 or less, the test meets a rule.
- If your test is just barely short on two of those rules, it also meets a rule and is abnormal, indicating mercury-induced mineral transport derangement.
- If mineral transport is deranged, you can't rely on the levels of the toxic elements in the top part. You ignore them. They have no meaning. You pay attention to the mercury you know is present.
- If mineral transport is normal and orderly, there should be about 15 bars between the yellow bands, about 6 into the yellow and probably one into the red. When the bars are even more towards the middle than this, mineral transport is normal.

The RMAL test offers one additional statistical feature: it identifies (by lavender coloring) essential elements that are more than three standard deviations from average. The likelihood this occurs by chance is quite small so this will usually represent toxicity or genetic uniqueness (which may be associated with toxicity).

With nice, normal, orderly mineral transport, the results in the toxic element section are representative. Reference ranges are measures of how people compare to each other. The length of the bars is not related to how toxic the person is. Some elements are not toxic at much higher levels than are present in most people. Bars that stick out into the red are significant, except for Uranium, tin, and titanium which aren't very toxic. Lead is very toxic compared to population levels so even a yellow range lead result can be significant. Other yellow range results seldom are.

When mineral transport is somewhere between normal and deranged, you get to play the odds as to whether mercury is present at toxic levels, and if the other toxic element section results are meaningful or not.[14]

Other laboratory evaluations are often abnormal in the presence of mercury and certain other heavy metal toxins. These are moderate elevations of blood and urine porphyrins, serum lactate and pyruvate, urine pyrroles, total cholesterol, ALT, and MCV. Antimony, mercury, and lead will sometimes produce low testosterone in men. When it is due to mercury, LH and FSH go down; when it is lead, they go up. Arsenic sometimes causes anemia.

When hair mercury is high in the presence of the signs and symptoms of mercury poisoning, you don't have to worry about counting; but it is still often valuable in providing confirmation of the actual toxic effects of the mercury.

There are some characteristic patterns commonly seen in mineral transport derangement. One is the mostly low presentation, satisfying the second rule above. In these tests the toxic elements typically are also very low, and a high one likely is significant. Just as the low essential elements do not accurately reflect body inventory, neither do the low levels of toxics guarantee their absence from the body. The patient has mercury and may or may not have other toxic elements.

Tests that satisfy the first rule have four or more essential elements with exceptionally high or low levels in hair, but not in the body itself. Thus, very high toxic element levels in hair likely do not mean toxic amounts are present.

Reference ranges are necessarily determined from a sample of the population in question – the entire human race. Random and nonrandom errors are necessarily present. One understandable nonrandom error is the failure to select subjects uniformly distributed around the globe. Thus, Doctor's Data uranium ranges are valid for people in the US Southeast, Midwest, and many other locales. In the coastal US Pacific Northwest hair lithium is always the low red range. People from the US Southwest, areas near Bankok Thailand,[15] and many other locales will as a rule have the uranium bar half way across the red zone. Near Bankok hair zirconium is in the red low (below 2.5%ile) range about 70% of the time. This is normal for those subpopulations.

As with any test, there are false normals. These are most likely to occur in a patient who was intoxicated many years ago and has not been exposed since. This goes with a history of rapid but long-past disease onset and relatively constant severity since: e.g., an autistic child aged 8 or over, or a schizophrenic person in their 30s who has not worsened since diagnosis at age 16. False positives are rare.

Any health care practitioner using hair tests needs to look at a large number from their local area to ensure they understand which results do not correspond to laboratory provided ranges. Those needing to look over hair tests on people from a variety of locations may view a sample on the web.[16] These are all people with chronic illness of the sort alternative practitioners treat, not a cohort of healthy people.

Dramatic high results may also occur due to contamination. Many dandruff shampoos contain
selenium sulfide – indeed one, Selsun Blue ® , is named for it. This leads to wildly elevated hair selenium that has no significance. Similarly for those who use zinc-containing shampoos. Bismuth elevations are often contamination from make-up. Cadmium is also a frequent contaminant.

The source of high hair barium is occasionally medical use as an X-ray contrast agent. Most of the time, it is a demonstration of basic chemistry. Cogeners are elements in the same column of the periodic table that have similar chemistry. Magnesium, calcium, strontium, and barium are one set of cogeners. In tests where Ca, Mg, and Sr are very elevated, Ba usually is as well. It is not present in the body at high levels in this case.

Due to the difficulty in establishing ranges, some toxic elements almost always appear at very low levels. These are beryllium, platinum, thallium and thorium. It is unusual to see bars for these at all.

A lack of appreciation of mercury-induced mineral transport derangement has led to a confused body of literature. For example, a very common presentation of the first rule where elements take on extreme values is for manganese, lithium, and cobalt to be very low. Studies have noted low manganese in autism,[17] and an association of both high AND low hair manganese with ADHD.[18]

Mercury increases liver cancer modestly and likely also ovarian cancer.[19] Thus, whether the low manganese in breast cancer[20] is due to an actual manganese deficiency or mercury-induced mineral transport derangement is an interesting question.

A common effect of mercury-induced mineral transport derangement is high hair and body aluminum at ordinary exposure levels. Autistic children have high aluminum.[21]
Seventy-four percent of autistic children respond to chelation,[22] and 75% of hair tests from autistic children satisfy the counting rule criteria for mercury toxicity.[23] Those autistic children with rule-positive hair tests invariably respond to chelation; those with rule-negative tests usually do not. It seems likely that the studies on autism cited above have confused an effect of mercury poisoning with a cause. It is not unreasonable to suspect breast cancer and ADHD may be

similar.

Few will see hair tests on random population samples. I have been able to view four different sets of these and to retain and analyze the data from three. Data from Thailand and North Carolina are very similar in terms of correlation between hair levels of the various elements. Both show the following characteristics: there is little correlation between the elements other than what one would reasonably expect between the cogeners Na K Rb and, separately, the cogeners Mg Ca Sr Ba moving together. Zirconium and aluminum, which have similar chemistry, also move together. Cobalt, barium, and manganese also move together, as do bismuth and iodine. Cadmium and zinc strongly anticorrelate. A relatively small number of element groupings move together. The 'counting' approach was derived assuming no significant correlations, which turns out to be valid.

Control children in an autism/controls study regarding hair test results showed about 25% of controls (as opposed to 75% of autistics) met a counting rule. This is in good agreement with the incidence of ADHD, asthma and allergies among similarly aged children at that place and time.[23]

Medical students in North Carolina showed about 40% met a rule.[24] About 40% of students at a private college in Bangkok also satisfy a rule. These are in reasonable agreement with the health histories of the medical students and the high pollution levels of Bangkok.

The typical use of a challenge test, or a hair test, is to convince the patient and physician that differential diagnosis has arrived at the correct answer: i.e., is someone diabetic, or is their diabetes due to mercury exposure earlier in life?[25] A properly interpreted hair test permits a large number of rule-outs to be conducted economically.

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