HAIR MINERAL ANALYSIS TO DEFINE PAST AND/OR CHRONIC EXPOSURES- A RESEARCH UPDATE

by: E. Blaurock-Busch, PhD

Hair Shaft

Hair mineral analysis (HMA) reflects how efficiently the root was nourished (or intoxicated) via the blood stream. As long as metals circulate, hair tissue will be supplied. This feeding and storing mechanism continues over time. Therefore, hair mineral levels reflect how well or poorly the hair tissue was supplied over time. HMA values do NOT reflect present variations as seen in blood or urine.

As long as toxins circulate in the blood stream, hair will be supplied. A 'normal' mercury or lead range does not necessarily exclude a metal burden. If a metal is no longer circulating and thus not supplying the hair root, it will not be detectable in hair. Additionally, hair tissue storage depends on the body's protein-metal binding ability, which decreases with age. This actually means that the hair analysis of an older, grey-hair person is more likely to detect borderline nutritional deficiency. Furthermore, even mildly elevated levels of any toxins in a grey-haired person are a sign of concern.

Over the past 10 years, method development and increased instrument sensitivity have significantly improved elemental analysis of blood, urine, hair and other specimen. Unfortunately, misinterpretation and misunderstandings of hair mineral analysis results abound. In spite of impressing research, this test is still criticized and viewed with caution.

Microwave digestion of hair in closed containers prevents evaporation of volatile metals such as arsenic and mercury.

Newer research also indicates that prenatal toxic exposure can be detected in hair of newborns or in young children. Through early detection, we could alert young parents to avoid additional metal exposure through immunization (i.e. mercury in thiomersal or now aluminium as a vaccine preservative), diet and water.

The following research summaries focus on hair analysis as a tool to evaluate toxic exposure for a number of reasons:

Research Summaries:

Maternal Fish Consumption, Hair Mercury, and Infant Cognition in a U.S. Cohort

Emily Oken,[1] Robert O. Wright,[2,3] Ken P. Kleinman,[1] David Bellinger,[4,5] Chitra J. Amarasiriwardena,[3] Howard Hu,[3,5] Janet W. Rich-Edwards,[1,6] and Matthew W. Gillman[1,7]

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Fish and other seafood may contain organic mercury but also beneficial nutrients such as polyunsaturated fatty acids. We endeavored to study whether maternal fish consumption during pregnancy harms or benefits fetal brain development. We examined associations of maternal fish intake during pregnancy and maternal hair mercury at delivery with infant cognition among 135 mother-infant pairs in Project Viva, a prospective

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U.S. pregnancy and child cohort study. We assessed infant cognition by the percent novelty preference on visual recognition memory (VRM) testing at 6 months of age. Mothers consumed an average of 1.2 fish servings per week during the second trimester. Mean maternal hair mercury was 0.55 ppm, with 10% of samples > 1.2 ppm. Mean VRM score was 59.8 (range, 10.9-92.5). After adjusting for participant characteristics using linear regression, higher fish intake was associated with higher infant cognition. This association strengthened after adjustment for hair mercury level: For each additional weekly fish serving, offspring VRM score was 4.0 points higher [95% confidence interval (CI), 1.3 to 6.7]. However, an increase of 1 ppm in mercury was associated with a decrement in VRM score of 7.5 (95% CI, -13.7 to -1.2) points. VRM scores were highest among infants of women who consumed > 2 weekly fish servings but had mercury levels ≤ 1.2 ppm. **Higher fish consumption in pregnancy was associated with better infant cognition, but higher mercury levels were associated with lower cognition. Women should continue to eat fish during pregnancy but choose varieties with lower mercury contamination.**

Author Comment: Hair mineral analysis can be used to evaluate the mercury status in women before pregnancy occurs, allowing for early intervention.

Mercury and Selenium Concentrations in Maternal and Neonatal Scalp Hair: Relationship to Amalgam-Based Dental Treatment Received During Pregnancy

Razagui I.B-A.; Haswell S.J. Biological Trace Element Research, Vol. 81, Number 1, July 2001, pp. 1-19(19)

Mercury and selenium concentrations were determined in scalp hair samples collected postpartum from 82 term pregnancy mothers and their neonates. Maternal mercury and selenium had median concentrations of 0.39 μg/g (range 0.1-2.13 μg/g) and 0.75 μg/g (range 0.1-3.95 μg/g), respectively, and corresponding median neonatal values were 0.24 μg/g (range 0.1-1.93 μg) and 0.52 μg/g (range (0.1-3.0 μg/g). Amalgam-based restorative dental treatment received during pregnancy by 27 mothers (Group I) was associated with significantly higher mercury concentrations in their neonates ($p < 0.0001$) compared to those born to 55 mothers (Group II) whose most recent history of such dental treatment was dated to periods ranging between 1 and 12 yr prior to pregnancy. In the Group I mother/neonate pairs, amalgam removal and replacement in 10 cases was associated with significantly higher mercury concentrations compared to 17 cases of new amalgam emplacement. Selenium concentrations showed no significant intergroup differences. The data from this study suggest that amalgam-based dental treatment during pregnancy is associated with higher prenatal exposure to mercury, particularly in cases of amalgam removal and replacement. The ability of a peripheral biological tissue, such as hair, to elicit such marked differences in neonatal mercury concentrations provides supporting evidence of high fetal susceptibility to this form of mercury exposure.

Author Comment: This is another study speaking against dental treatment or removal of amalgam during pregnancy.

Hair Element Concentrations in Females in One Acid and One Alkaline Area in Southern Sweden

Ingegerd Rosborg, Bengt Nihlgård, and Lars Gerhardsson. AMBIO: A Journal of the Human Environment. Vol. 32, Issue No7, Nov. 2003 pp. 440–446

Concentrations of 34 trace elements in hair have been determined in 47 females from an acid region in southern Sweden, who were compared with 43 females from an alkaline area. The concentrations of these elements in hair and drinking water were determined by inductively coupled plasma optical emission spectroscopy and inductively coupled plasma mass spectrometry. **The hair concentrations of boron and barium were significantly higher ($p < 0.001$) in hair samples from the acid region, the hair levels of calcium, strontium, molybdenum, iron, and selenium were significantly higher ($p < 0.001$) in the alkaline region.** For some metals, e.g. calcium, lead, molybdenum, and strontium, there were positive correlations between the concentrations in hair and water (r_s = 0.34–0.57; $p \leq 0.001$), indicating the importance of intake from minerals in water. The increased ratio of selenium/mercury concentrations in hair samples obtained in the alkaline district ($p < 0.001$) indicates that these subjects may have better protection against the toxic effects of mercury.

Author comment: Metal uptake is influenced by pH.

Hair iron content: possible marker to complement monitoring therapy of iron deficiency in patients with chronic inflammatory bowel diseases?

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Chemistry, Vol 42, 1270-1274, Copyright © 1996 by American Association for Clinical Chemistry

Measurements of the concentration of iron in hair from 10 patients with chronic inflammatory bowel diseases and from 10 healthy controls showed that the iron concentrations were significantly ($P < 0.05$) lower in patients before iron intake than in controls. Three weeks after beginning iron treatment, the hair iron concentrations were found to be significantly correlated ($r = 0.68$; $P < 0.05$) to reticulocyte counts.

Changes in the hair iron concentrations were accompanied by similar changes in the concentrations of the markers most commonly used to diagnose and monitor iron deficiency. The results suggest that quantification of hair iron may be useful to complement evaluations of the body iron status.

Serum and hair trace element levels in patients with epilepsy and healthy subjects: does the antiepileptic therapy affect the element concentrations of hair?

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Hair magnesium (Mg), zinc (Zn), copper (Cu), and manganese (Mn) levels, and serum Zn and Mg levels were measured by atomic absorption spectrophotometer in patients with epilepsy ($n = 33$) and healthy subjects ($n = 21$), and results obtained were statistically compared. The mean hair Cu, Mg, and Zn levels of epileptic patients were significantly lower than the levels of control subjects. There was no significant difference between epileptic patients and control subjects in respect to the mean Mn levels. Mean serum Mg levels in epileptic patients showed significant difference, but serum Zn levels were similar among both groups. When the effects of anticonvulsant therapy on Cu, Zn, Mn, and Mg in the hair, and Mg and Zn in the serum were analyzed in epileptics, there was no significant difference between the patients with or without therapy. Likewise, the mean trace element levels in epileptics showed no significant difference according to the type of antielpileptic drug and seizure, and gender. **We suggest that the changed element status (Zn, Mg, and Cu) in hair play an indicator role in the diagnosis of epileptic patients.**

Epileptic child

Toxic Metal Exposure in the Children of Punjab, India

Blaurock-Busch E., Friedle A., Godfrey M., Schulte-Uebbing C., Carin Smit
Clinical Medical Insights: Therapeutics only, NZ. Open access publication. June 2010

Test results documented that hair and urine mineral analysis results support each other. This is of interest, because hair analysis evaluates past exposure while urine analysis detects immediate exposure. Test results indicate evidence of past and immediate exposure to one or more metals. Barium, Cadmium, Manganese, Lead and Uranium concentrations were elevated in the hair and urine of children. Hair mineral test results for the 114 children age 12 and younger showed some type of toxic metal exposure for each one of the children; 88% exceeded the uranium reference range for hair. This indicates past and chronic exposure.

After renal evaluation, 55 children age 3-12 years of age who passed the criteria were selected for urine baseline testing. Urine baseline concentrations are a direct reflection of immediate exposure. Of the 55 children, 47 showed elevated urine concentrations for one or more of the toxins listed above, demonstrating immediate exposure.

Autistic boy, diagnosed with severe metal burden

55 children age 3-12 with healthy renal function were selected for a DMSA (Dimercapto succinic acid) urine challenge test. Results showed that 98% of this group showed lead concentrations above the baseline level, demonstrating lead binding and excretion. The DMSA challenge did not affect barium, cadmium, manganese and uranium, suggesting that for these elements DMSA may not be the chelating agent of choice.

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Toxic Metals and Essential Elements in Hair and Severity of Symptoms among Children with Autism

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By comparing hair concentration of autistic vs nonautistic children, elevated hair concentrations were noted for aluminum, arsenic, cadmium, mercury, antimony, nickel, lead, and vanadium. Hair levels of calcium, iron, iodine, magnesium, manganese, molybdenum, zinc, and selenium were considered deficient. There was a significant positive correlation between lead & verbal communication (P = 0.020) and general impression (P = 0.008). In addition, there was a significant negative correlation between zinc & fear and nervousness (P = 0.022).

Author Conclusion: Our data supports the historic evidence that heavy metals play a role in the development of ASD. In combination with an inadequate nutritional status the toxic effect of metals increase along with the severity of symptoms.

About the Author

Dr. E.Blaurock-Busch PhD is the research director of Micro Trace Minerals Laboratory in Germany. She is a member of the British Society of Ecological Medicine and the European Academy for Environmental Medicine (EUROPEAM) and Scientific Advisor to the German Medical Association of Clinical Metal Toxicology **(KMT)** and the International Board of Clinical Metal Toxicology (IBCMT) She can be reached at ebb@microtrace.de.

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ICP-MS with cell technique, allowing accurate measurements.

Punjab boy, diagnosed with severe developmental problems. Hair and urine analysis demonstrated unusually high metal burden

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