

## **Hair Mineral Analysis- a review and update based on current research**

Dedicated to critics such as Stephen Barrett and cohorts

by

**E.Blaurock-Busch PhD**

We believe what we like to believe. Much of this applies to hair mineral analysis, a test that *appears* controversial, because few other laboratory assessments are surrounded by as much half-truths as this one. Can hair analysis evaluate the sodium or potassium status of a patient? No, it cannot. Can it evaluate the patient's metabolic status? No! Can it assess a chronic metal burden? Yes. Does it reflect a patient's nutritional status? Only to a degree.

Sound research supports the application of this laboratory method for *certain* evaluations, it also provides reliable documentation demonstrating its limits. Like all laboratory results, hair mineral analysis is best viewed in combination with supportive laboratory assessments. In fact, all laboratory diagnostics face limitations and need supportive evaluation and careful interpretation. It cannot be said enough: when it comes to evaluating, and interpreting a patient's mineral status, we should not rely on one test only.

When we evaluate a patient's mineral or toxic element status, we have options:

**Urine mineral analysis (UMA)** shows us the body's ability to excrete. It does not reflect the patient's nutritional status. UMA only shows if the elemental intake and utilization allowed adequate excretion levels.

- The toxic metal content of a nonprovoked urine does not necessarily indicate intoxication. Results may be influenced by the metal intake. Excretion is naturally enhanced when a person eats mercury and/or arsenic-rich tuna prior to sampling, or takes metal-rich algae products, or smokes.

**Blood minerals** circulate in the system for an estimated 72 hrs before excretion or utilization and storage takes place.

- Homeostasis does not regulate all metals and a temporary lowering of blood values may not indicate an acute nutritional deficiency.
- Smoking, eating metal-rich foods or products prior to sampling will elevate the blood metal count and may not reflect a metal burden.

**Hair mineral analysis (HMA)** reflects how efficiently the root was nourished (or intoxicated) by the blood stream. As long as metals circulate, hair tissue will be 'fed'.

- This feeding and storing mechanism continues over time. Therefore, hair mineral levels reflect how well or poorly the hair tissue was supplied over time. Daily variations as seen in blood or urine are negated.
- As long as toxins circulate in the blood stream, hair will be supplied. A 'normal' mercury range does not necessarily exclude a metal burden. If a metal such as Hg crossed the blood brain barrier, it will no longer be seen in the circulating blood stream- unless appropriate detoxification methods are employed.
- Hair tissue storage also depends on the body's protein-metal binding ability, which decreases with age.

Improvement in method development and increased instrument sensitivity have contributed to supporting hair mineral analysis issues that were/are not well understood, and have been criticized ad nauseam. The following research summaries are aimed to improve understanding of a rather complex test.

The essential statements of these excerpts have been slightly trimmed without changing content meaning. Highlighted parts are commented by the author, reflecting her opinion.

## 1. Arsenic and other elements in hair, nails, and skin-scales of arsenic victims in West Bengal, India.

Samanta G., Sharma R., Roychowdhury T., Chakraborti D. Department of Civil and Environmental Engineering, University of Houston, N 107 Engineering Bldg 1, Houston, TX 77204-4003, USA. [gsamanta@mail.uh.edu](mailto:gsamanta@mail.uh.edu). Sci Total Environ. 2004 Jun 29;326(1-3):33-47.

For the first time, biological tissues (hair, nails, and skin-scales) of arsenic victims from an arsenic affected area of West Bengal (WB), India were analyzed for trace elements. Analysis was carried out by inductively coupled plasma-mass spectrometry (ICP-MS) for 10 elements (As, Se, Hg, Zn, Pb, Ni, Cd, Mn, Cu, and Fe). A **microwave digester** was used for digestion of the tissue samples. To validate the method, certified reference materials--human hair (GBW 07601) and bovine muscle (CRM 8414)--were analyzed for all elements. The W test was used to study the normal/log normal distribution for each element in the tissue samples. For hair (n=44) and nails (n=33), all elements show log-normal distribution. For skin-scale samples (n=11), data are not sufficient to provide the information about the trend. Geometric mean, standard error, and range for each element were presented and compared with literature values for other populations. This study reveals the higher levels of toxic elements As, Mn, Pb, and Ni in the tissue samples compared with available values in the literature. **The elevated levels of these toxic metals in the tissues may be due to exposure of these elements through drinking water and food.** This study reveals that in the arsenic-affected areas of WB, the concentrations of other toxic elements in drinking water and foodstuff should be monitored to evaluate the arsenic poisoning.

**Comment:** since closed vessel microwave digestion is used, the accuracy of the analysis of elements such as arsenic, mercury, and selenium improved dramatically. Before microwave digestion, hair was acid digested in open vessels under heat. This caused the more volatile metals to escape, resulting in false low values of metals such as arsenic, mercury and selenium.

In spite of the 'maybe due to exposure' statement, this study indicates that hair tissue reflect long term exposure.

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

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

<sup>1</sup>Department of Ambulatory Care and Prevention, Harvard Medical School and Harvard Pilgrim Health Care, Boston, Massachusetts, USA; <sup>2</sup>Department of Pediatrics, Boston Children's Hospital and Harvard Medical School, Boston, Massachusetts, USA; <sup>3</sup>Channing Laboratory, Brigham and Women's Hospital and Harvard Medical School, Boston, Massachusetts, USA; <sup>4</sup>Department of Neurology, Boston Children's Hospital and Harvard Medical School, Boston, Massachusetts, USA; <sup>5</sup>Department of Environmental Health, <sup>6</sup>Department of Epidemiology, and <sup>7</sup>Department of Nutrition, Harvard School of Public Health, Boston, Massachusetts, USA

Address correspondence to E. Oken, Department of Ambulatory Care and Prevention, Harvard Medical School and Harvard Pilgrim, 133 Brookline Ave., Boston, MA 02215 USA. Telephone: (617) 509-9835. Fax: (617) 859-8112. E-mail: [emily\\_oken@harvardpilgrim.org](mailto:emily_oken@harvardpilgrim.org)

Fish and other seafood may contain organic mercury but also beneficial nutrients such as n-3 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 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.**

**Comment:** Hair mineral analysis reflects long term exposure. It can be used to evaluate the mercury status in women before pregnancy occurs, allowing for nutritional corrections. To further promote an understanding it should be noted that during the digestion (ashing) of hair, all organic mercury is broken down. Hence, hair mineral analysis results reflect total inorganic mercury.

### **3. 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](#), Volume 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 preliminary 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.**

**Comment:** Transplacental movement of mercury has been documented. This is another study speaking against dental treatment with, or removal of, amalgam during pregnancy. It also supports infant hair testing.

#### **4. 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 | [Abstract](#) | [PDF \(125K\)](#)

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.

**Comment:** Metal uptake is influenced by pH.

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

E Bisse, F Renner, S Sussmann, J Scholmerich and H Wieland . Department of Clinical Chemistry, University Hospital, Freiburg im Breisgau, Germany. Clinical 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.**

**Comment:** none needed.

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

A. İlhan<sup>a</sup>, Efkân Uz<sup>b</sup>, Sinem Kali<sup>a</sup>, Ahmet Var<sup>c</sup> and Omer Akyol<sup>b</sup> <sup>a</sup>Department of Neurology, İnönü University, Turgut Özal Medical Center, 44069, Malatya, Turkey <sup>b</sup>Department of Biochemistry, İnönü University, Turgut Özal Medical Center, 44069, Malatya, Turkey <sup>c</sup>Department of Biochemistry, Fırat University, Faculty of Medicine, Elazığ, Turkey

Eur J Neurol 6:705–709 © 1999 Lippincott Williams & Wilkins

In this study, 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 antiepileptic 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.**

**Comment:** Excellent observation on how long term metal status affects disease development.

### **7. Hair Zinc Levels in Normal and Malnourished Infants**

JOSÉ GARROFE DÓREA, Ph.D., Associate Professor, ZULEICA PORTELA ALBUQUERQUE, M.D., M.Sc., Assistant Professor and LUIZ ANTÔNIO BORGGO, B.Sc., Faculty of Health Sciences, University of Brasilia . Journal of Tropical Pediatrics 1983 29(1):58-60; © 1983 by [Oxford University Press](#)

Hair zinc levels and nutritional status were studied in children from three to 6.5 months of age. Hair zinc levels in 10 malnourished children (206 ug/gm hair) were significantly lower than those of 10 controls (333 ug/gm hair). It is recommended that studies of the effect of nutrition on hair **zinc levels narrowly define the age groups, especially for young infants, and clearly state the method used to determine the study and control groups.**

**Comment:** Correct, and while the author has developed reference ranges for children, the age groups may have to be more defined.

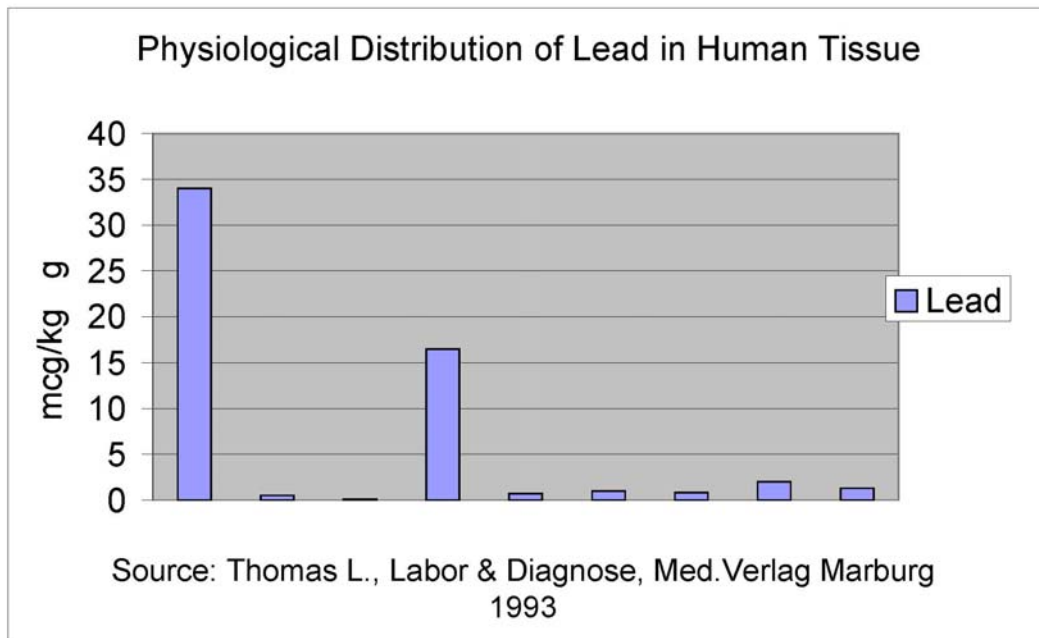
### **8. Lead, copper, zinc, and magnesium levels in hair of children and young people with some disorders of the osteomuscular articular system.**

Lech T., Institute of Forensic Research, Kraków, Poland. [Biol Trace Elem Res](#). 2002 Nov;89(2):111-25.

The lead, copper, zinc, and magnesium contents of scalp hair taken from 173 children aged 1-15 yr and young people (16-18 yr) with certain disorders of the osteomuscular articular system (osteomuscular pains of unknown origin, once described as "growing pains") were measured, using the flame atomic absorption spectrometry method, and then compared with those of 108 normal, healthy children. **The research showed increased average levels of lead (a statistically significant  $p < 0.05$  in both the overall group of children, and in those over 11 yr old), and zinc (increased in the total group, in a statistically significant way at  $p < 0.10$  only in adolescents over 15 yr old) and decreased levels of copper (although not significantly) in the hair of children suffering from "rheumatic" diseases, as compared with controls. The magnesium levels for the total group of ill children were admittedly enhanced, but in the youngest children, the levels were reduced. The values of the Mg/Pb and Mg/Zn ratios were lower (in the youngest children, 70% decrease of the Mg/Pb ratio) and Zn/Cu were higher in the group of children suffering from rheumatic diseases than in the healthy children. The difference of Mg/Pb ratio between the total controls and rheumatic subjects was**

statistically significant at  $p < 0.05$  and the Zn/Cu at  $p < 0.10$ . The Mg/Zn ratio was not statistically significant.

**Comment:** 'Growing pains' have been contributed to lead overexposure. Lead deposits in bone, and to a similar degree in hair. See Table one.



This Polish research publication also indicates the complexity of the interpretation of hair mineral analysis data. As stated initially, hair mineral analysis results should be carefully evaluated by a physician understanding mineral analysis. The unfortunate practice of patients ordering hair analysis directly through the mail can only cause confusion and harm the image of an otherwise useful test.

.....

**Author's e-mail:** [ebb.blaurock@gmx.de](mailto:ebb.blaurock@gmx.de) or [ebb@microtrace.de](mailto:ebb@microtrace.de)