Observations on Trace and Toxic Elements in Hair and Serum

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The hair test for trace minerals may be quite unreliable because of the many cosmetic manipulations that are applied to head hair. Even pubic hair analyses are not as reliable as blood serum. The ultimate answer to the actual level of tissue trace minerals is the analysis of skin, but these biopsy punches are obviously less acceptable to the patient than a haircut. Yet another research need is the careful study of several tissues from the same patient with samples done at monthly intervals for at least eight months. This patient should have the initial trace metal or toxic metal imbalance carefully assayed and then corrected by adequate nutritional or chelation therapy for an eight-month period. The tissues which should be sampled and studied simultaneously are head hair, pubic hair, fingernails, toenails, skin cuticle, skin punch biopsy, blood serum, heparinized whole blood, heparin control, and packed red blood cells. All of these samples are easily available, and patients with high copper and low zinc levels of their blood serum are all too abundant among schizophrenics and hypoglycemics.

One can generalize our experience, however, as follows:

(1) "Prell Shampoo" of Proctor and Gamble contained mercury as a preservative. This gave high Hg levels in the hair assay procedure. At our request they discontinued this for the U.S.A. market! What other shampoos still contain mercury?

(2) Low sodium and potassium in hair is a general index of adrenal cortical stress. Most psychiatric patients are stressed, so this is nonspecific and need not be specifically treated with extra salt or potassium.

(3) Calcium and magnesium rise with age in the female (but not the male), and very high Ca and Mg may be a sign of functional hypoglycemia which disorder is twice as frequent in the female as in the male.

(4) The hair of the schizophrenic patient (if of the pure histapenic type) may be off scale in copper and low in zinc. This would apply to the paranoid and hallucinatory types of schizophrenic patients.

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TABLE 1

Pertinent Correlation of Hair vs. Age

of 94 Schizophrenic Patients - Allan Cott Data

		N	Slope	Intercept	r	P
Females	Cu/age Mn/age	44 44 44 44	5.5 -0.68 0.00 0.79	13.2	+ 0.71 0.02 0.001	< 0.001
	Zn/age Mg/age			18.3	+ 0.66	N.S.
				18.1		N.S.
				6.8		< 0.001
Males	Mn/age Mg/age	50 50	-2.2 -0.09	-25.4 22.6	-0.54 0.02	< 0.001 N.S.

(5) Manganese decreases with age in the male but not the female. Low hair manganese may occur in schizophrenics and should be treated with zinc and manganese (Ziman). The appropriate dose is approximately 4 mgm of a manganese salt given twice a day. "Vicon Plus" of Meyer Laboratories and "Ziman Fortified" of Willner Chemists contain this, plus zinc, plus magnesium. In older patients manganese may elevate blood pressure, but zinc and magnesium lower blood pressure, hence a shift to Vicon-C of Meyer Laboratories or Zimag C of Willner Chemists should be made. These preparations contain vitamins plus zinc and magnesium.

(6) Little is known about iron in hair. One might expect this to be high in zinc deficiency and low in rheumatoid arthritis as are the serum levels of iron. Tissue levels of iron may be high in both disorders. Many middle-aged patients who have taken iron all their adult years will develop a slate grey color in their skin. This is siderosis and requires continued treatment with zinc and manganese and even iron chelation therapy. The rheumatoid arthritic patient has a low serum iron, but high levels in the tissues and joints. Iron therapy should not be used until the rheumatic patient has been given zinc and manganese for several months. This usually raises the serum iron level to 100 -120 mcg percent, which is the **only** normal iron level. Higher or lower levels are owing to disease process or zinc/manganese deficiency. Excess serum iron will go towards normal within a month of Ziman therapy, whereas high serum copper may require six to eight months of therapy. The serum copper may rise for a period of two to three months as the tissue copper is mobilized. Definite improvement may be delayed until the serum copper level starts falling at the end of two to three months of zinc and manganese therapy.

(7) If on leaded fuel, each large auto engine spews forth 2,000 gm of fine particulate lead each year; the particle size is 0.1u to 0.5u, which allows penetration deep into the lungs. In our cities these particles may be layered in the air above the ground so that the concentration is greater in the air and dust just above the ground. Fine lead dust also rises high in the stratosphere where it is deposited in the ice cap of Greenland. Leaded gasoline was introduced in 1924. Since 1940 the lead in the ice of Greenland has risen steadily. This is not true for the ice cap of Antarctica because in the Southern Hemisphere the auto engine pollution is much less (see Schroeder, 1973). The family dog in the city gets the biggest dose of lead, the child is next, and the adult least in exposure because the air intake apparatus is higher off the ground in adults. Dr. Caprio and his colleagues (1974) have studied the blood levels of 5,226 children living near the congested

traffic lanes of Newark. The closer to the traffic lane the higher the level of lead in the blood. Some patients living close to the arterials had a poisonous level of lead. Old houses may have lead dust from the old flaking paint. City dwellers can be expected to have a higher level of lead in their hair and blood. The whole blood test for lead is a more reliable index of poisoning than is the hair level. (8) Cadmium is very high downwind from zinc smelters, and atmospheric cadmium has produced poisoning. This poisoning is seldom determined in hair analysis, but can be determined by AAS analysis of blood. Since auto engines have cadmium plate and cadmium in the moving parts, the exhaust of gasoline engines also pollutes the atmosphere with cadmium. The sewage sludge of our cities, including Washington, D.C., is so high in cadmium that it is not usable as fertilizer. Cigarette smoke contains considerable cadmium, so smokers' tissues should be higher in cadmium. The blood serum of smokers is also higher in copper which decreases when they stop smoking. This may be reflected in hair analysis. (9) Hair and serum copper may be

TABLE 2

Comparison of Zinc and Copper in Hair

of 366 Schizophrenics and Normals mgm %

		Zinc Normal*		Copper Normal*	
		Schizophrenic		Schizophrenic	
Females	Aged 1-12	19.0	20.2	2.0	7.7
	13-30	16.0	20.5	2.8	6.4
	31-60	16.0	19.9	2.2	5.3
Strain Lab, Cleveland		20.0		4.0	
Hartley Labs		14.9		3.5	
BioMed Data		15.0		3.4	
Klevay (1970) (Panamanian)		15.9		3.13	
Males	1-12	14.7*	9.8	3.4*	2.8
	13-30	18.0	16.5	3.3	5.6
	31-60	15.0	15.2	1.8	3.5
Strain Lab, Cleveland		16.5		6.0	
Hartley Labs		14.2		2.4	
BioMed Data		14.0		2.4	
Klevay (1970) (Panamanian)		14.1		2.85	
Both Sexes					
Albion Lab		14.0		2.85	
Mineral Lab		17.0		2.75	

•Data of Petering et al. (1971)

high in hypertensives as well as in schizophrenics. Young ladies on oral contraceptives will have high serum copper, and their hair may be so high as to be termed "off scale." Baldness in young women may occur with the high copper tissue level. Wilson's disease is very rare, but here also the copper in hair may be "off scale." Copper in fingernails is very high in infants with cystic fibrosis. Kidney patients undergoing dialysis against tap water will absorb copper from the plastic and the water, so again very high serum and hair copper may result. Copper should never be given to an adult since only infants, particularly premature, have copper deficiency. Adult man's copper burden increases with age and can be aggravated by routine "vitamin and mineral capsules," some of which contain 2 mgm of copper per capsule. The misguided use of copper dates back to 1928 when Dr. Hart of Wisconsin found copper helped iron deficiency anemia in rats.

(10) Zinc levels of serum and also hair can be paradoxical depending on the degree of Pyridoxine (B6) deficiency. If a patient is both zinc and B6 deficient, then serum and hair zinc levels will be low. If, however, the patient is primarily B6 deficient, as many mauve factor (pyrolleuria) patients are, then the zinc accumulates in the serum and hair because zinc apparently needs B6 for normal use. We have had pyroluric patients with hair zinc "off scale," and we have had these same patients' non-hemolyzed blood serum show levels of 200 to 500 mcg percent. Both Petering et al. (1971) and Klevay (1970) find a rise in the zinc content of hair at the 15- to 20-year period. This is probably not a pubertal effect since it is later and occurs in both sexes. This is the age-group in which stress-induced pyrolleuria occurs, and the rise in zinc in the hair could therefore be due to a Pyridoxine deficiency.

The RBCs produced under conditions

TABLE 3 Patient D.S., Aged 60 - Hair, Minerals and Chelation Therapy

Diagnosis: Hypoglycemia and High Copper

Female Normal Mean		4/73	8/73	1/74	6/74	Comments
(645)	Ca	1058	485	430	776	Downward Trend?
(87)	Mg	708	126	265	259	Downward Trend?
(250)	Na	11	15	23	369	Upward Trend
(98)	K	26	10	20	195	Upward Trend
(34)	Cu	1018	484	448	367	Downward Trend
(150)	Zn	177	184	182	222	No change (maybe up)
(40)	Fe	13	15	9	21	No change
(4.5)	Mn	38	16	1	32	Probably inaccurate
(30)	Pb	17	50	21	27	No change

^ 1/74 Start Vicon Plus as a source of Zn, Mn, and Mg ^ 5/73 Intravenous Chelation daily for 12 days

All data in ppm (10ppm = 1 mgm%) Continued General Therapy Hypoglycemic Diet and 3.0 gm NaCI each day

These hair analysis data were brought by a patient for interpretation. Fortunately, the hair tests were all done by one lab in West Chicago.

of B6 deficiency are low in hemoglobin, more easily hemolyzed, and have a shorter half life. Continued hemolysis may give rise to splenic pain in pyrolleuria, and perhaps this hemolysis may go undetected by inspection of blood samples. The serum zinc, if high, declines to 100 - 150 mcg percent with adequate B6 and zinc therapy. Presumably the hair zinc also declines. Eleven percent of 240 schizophrenic patients had a serum level of zinc below 80 mcg percent. Relief of their symptoms can be dramatic when given any pure salt of zinc. Dramatic improvement has also occurred with the eating of oysters - a food which has 128 mgm of zinc per 100 grams (3 ounces). Copper is also high in oysters as is cadmium if the seawater is polluted. Patients who are zinc deficient have white spots in the fingernails (Pfeiffer and Jenny, 1974). Zinc is dissipated by virus infections, and therefore the white spots may occur with influenza or other virus infections. The fingernail requires six months to be replaced, so one can estimate the approximate time of the event which caused the white spots (leukonychia).

(11) Chromium is needed, and the content in the tissues of civilized man decreases with age and decreases in women with each pregnancy. Chromium is also dissipated with the eating of sugar or refined carbohydrates. Severe intolerance to alcohol and adult-type diabetes results. Dr. Walter Mertz of the Human Nutrition Lab, Beltsville, Maryland, finds trivalent chromium to be carried in an organic complex termed the glucose-tolerance factor (GTF). The factor contains (1) atom of Cr+ + + (2) niacins (1) glycine (1) glutamic acid (1) cysteine and possibly phosphate. This GTF will perhaps be as valuable in medicine as vitamin B12, which, is also a trace element-containing vitamin. The crystalline product is nontoxic and is easily absorbed after oral administration. The daily human dose is estimated at 5 mgm. Hopefully the GTF should be available for clinical use by late 1975.

TABLE 4 Zinc - Hair Analysis (Data of Kievay, 1970)

Age in Years	Females	Males
0- 5	14.8	14.7
6-10	11.3	12.7
11-15	14.8	12.6
16-20	21.0*	16.3*
over 20	16.7	14.2

All data in mg/100gm

*Age of onset of pyrolleuria = Vitamin B6 deficiency?

The analysis of hair in the late teen-age period may disclose very high zinc levels. The mean age of onset of pyrolleuria is the late teens when vitamin B6 deficiency makes for high levels of zinc in blood serum and hair.

From these observations one can see that much more study on hair, skin, nails, and blood must be done before we can interpret the meaning of trace and poisonous metals in hair. At present, research funds for this purpose are woefully inadequate.

Summary

High copper or low zinc levels of hair may indicate schizophrenia. Low manganese may indicate schizophrenia. High calcium and magnesium may indicate hypoglycemia. High lead indicates proximity to vehicular traffic, and high mercury may indicate poisoning or the use of mercury-containing shampoos. A high zinc level may indicate vitamin B6 deficiency. Low sodium and potassium may indicate adrenal cortical stress.

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