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Hair Analysis – It's Lack of Utility in Clinical Decision Making with Pediatric Patients

Case: DR is a 3 year old who you have been following since birth. She was the product of an uncomplicated, term pregnancy and was delivered vaginally with Apgar scores of 7 and 9. Her birth weight was 7 lbs 3 oz. Since birth, her height, weight and head circumference have consistently been between the 25th and 50th percentiles and she has had no major illnesses. Since her 18 month visit, you have been concerned that her language and fine motor milestones have been delayed. At 24 months, you referred her to a developmental specialist who confirmed that her language skills were at the 15-18 month level and her fine motor skills were at the 20-22 month level. The detailed history by the developmentalist and a subsequent evaluation by a geneticist revealed no obvious etiology for the developmental delay. When the mother and child come in for the 3-year visit, the mom brings in the results of a hair analysis that was ordered by another physician. The analysis shows elevated levels of mercury, aluminum, lead and chromium. The other physician has recommended chelation and indicated that it will improve the child's development. The mother is asking your opinion and would really prefer that you do the chelation.

Comments:

It has been well documented that many patients simultaneously use complementary/alternative medicine practices/practitioners and allopathic medicine practices/practitioners.[1,2,3,4] There are a number of practitioners, including some physicians, who claim that hair analysis can diagnose a large number of health problems – both metal toxicities and dietary insufficiencies.[5] Hair analysis, subsequent recommendations for management of abnormalities detected and oral chelating agents are available on the Internet as well as in office settings.[6]

When a diagnosis of metal toxicity is made on the basis of hair analysis, chelation is often recommended. Chelators bind metallic ions and remove them from the body, usually by renal excretion. Pediatricians, pediatric nurse practitioners, family physicians and family nurse practitioners may be confronted with parents asking about hair analysis or who are concerned that their children have some metal toxicity on the basis of the results of hair analysis that has already been done.

Hair grows from the hair follicle. As the hair is being formed in the generative zone of the hair follicle, it is in contact with and receives nourishment from the blood. As the hair moves upward in the hair follicle, it no longer receives nourishment from the blood and consists of dead cells. Once the hair reaches the surface of the skin, it then comes into contact with all things that come into contact with the skin. Because of the original contact with the blood, it is thought by some that the chemical makeup of the hair reflects what was in the blood and the timing of the presence of a toxicant or other substance in the blood. While this may be true to a very limited

extent, there are a number of factors that make the hair an unreliable clinical indicator for some chemicals that have been in the body.

Hair comes into contact with a number of chemicals that are in the air and in water that is used to wash the hair. Hair is also in contact with chemicals in shampoos (an issue primarily for selenium[7,8]), and any dyes, gels, sprays or other cosmetics that may be placed on the hair.[8] Because there is no standardized method for cleaning these external contaminants off of the hair prior to analysis, the potential for inaccurate results from external contamination is great. There is no way to tell in the laboratory if a chemical is contained within the hair, and therefore came from with in the body, or if it is on the surface of the hair and did not come from within the body.

Hair analysis has utility in measurement of methylmercury[9], measurement of cotinine[10], in certain types of legal cases[11,12], and perhaps for identification of substances of abuse[13,14]. It should be noted that methyl mercury and some of the substances of abuse have no external sources which serve as potential means of contaminating hair. Hair analysis also has some utility in research studies where there is very rigid standardization and quality control.[9]

Articles published in the peer reviewed literature make it quite clear that hair analysis is unreliable as a diagnostic tool. In an important study, the researchers took hair from the head of a single individual and sent portions of the sample to six laboratories. The results varied widely from laboratory to laboratory.[15] These researchers pointed out that the normal ranges and interpretations of results also varied widely from laboratory to laboratory. Other papers make similar points.[16*,17,18,19,20,21]

The US Agency for Toxic Substances and Disease Registry (ATSDR) released a report on hair analysis at the end of 2001.[22*] The conclusion of the report was that "[f]or most substances, insufficient data currently exist that would allow the prediction of a health effect from the concentration of the substance in hair. The presence of a substance in hair may indicate exposure (both internal and external), but does not necessarily indicate the source of exposure." The report also pointed out a number of gaps.

- "The lack of standard procedures for sample collection.
- The lack of standardization of methods and quality assurance/quality control (QA/QC) among laboratories.
- The possible over-interpretation of results far beyond the current body of scientific data and in light of limitations of techniques and procedures.
- External contamination from a variety of sources, which lowers sensitivity (e.g., environmental, hair treatments, personal hygiene, and others).
- The lack of a body of evidence to demonstrate the effect of washing hair on analytical results.

[*] Reference 16 is the paper published on the basis of the report cited in reference 22.

- The lack of reference ranges in which to frame the interpretation of results. Reliable reference ranges are needed—specifically, background or expected ranges in different geographical areas or regions. Reference ranges should be applicable to population of interest. ...

- The lack of data related to uptake/incorporation of environmental contaminants into hair. For both metals and organic compounds, neither kinetic models nor metabolite data are known or fully understood. Identifying metabolites of substances of interest would be helpful, because they could serve as markers of internal exposure.

- The lack of correlation between levels in hair and blood and other target tissues.

- The lack of an epidemiologic database linking substance-specific hair levels and health end points."

Conclusions

1. Hair analysis is not useful for the diagnosis of clinical problems in pediatric patients.
2. There is a lack of standardization in the methodology of collection and analysis of hair samples.
3. There is a lack of clinical correlation between the measurement of levels of toxicants in hair and clinical syndromes.
4. There are no data on "normal" reference ranges for chemicals in the hair of children.
5. Parents should be discouraged from having hair analysis done and clinical decision regarding the management of possible toxic exposures should not be made on the basis of hair analysis.

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[1] McFarland B. Bigelow D. Zani B. Newsom J. Kaplan M. Complementary and alternative medicine use in Canada and the United States. American Journal of Public Health. 92(10):1616-8, 2002.
[2] Wilson KM. Klein JD. Adolescents' use of complementary and alternative medicine. Ambulatory Pediatrics. 2(2):104-10, 2002.
[3] Sawni-Sikand A. Schubiner H. Thomas RL. Use of complementary/alternative therapies among children in primary care pediatrics. Ambulatory Pediatrics. 2(2):99-103, 2002.
[4] Ottolini MC. Hamburger EK. Loprieato JO. Coleman RH. Sachs HC. Madden R. Brasseux C. Complementary and alternative medicine use among children in the Washington, DC area. Ambulatory Pediatrics. 1(2):122-5, 2001.
[5] For example, http://www.cgiworker.com/danlist/danlist.html (Accessed April 16, 2003)
[6] For example, http://www.extremehealthusa.com/hair-test.html. (Accessed April 16, 2003)
[7] LeBlanc A. Dumas P. Lefebvre L. Trace element content of commercial shampoos: impact on trace element levels in hair. Science of the Total Environment. 229(1-2):121-4, 1999.
[8] DiPietro ES. Phillips DL. Paschal DC. Neese JW. Determination of trace elements in human hair. Reference intervals for 28 elements in nonoccupationally exposed adults in the US and effects of hair treatments. Biological Trace Element Research. 22(1):83-100, 1989.
[9] Cernichiari E, et al. Monitoring methylmercury during pregnancy: maternal hair predicts fetal brain exposure. Neurotoxicology. 1995 Winter;16(4):705-10.
[10] Eliopoulos C, et al. Hair concentrations of nicotine and cotinine in women and their newborn infants. JAMA. 1994 Feb 23;271(8):621-3.
[11] Moeller MR. Fey P. Sachs H. Hair analysis as evidence in forensic cases. Forensic Science International. 63(1-3):43-53, 1993

[12] Wennig R. Potential problems with the interpretation of hair analysis results. Forensic Science International. 107(1-3):5-12, 2000
[13] Sachs H. Kintz P. Testing for drugs in hair. Critical review of chromatographic procedures since 1992. Journal of Chromatography. B, Biomedical Sciences & Applications. 713(1):147-61, 1998
[14] Spiehler V. Hair analysis by immunological methods from the beginning to 2000. Forensic Science International. 107(1-3):249-59, 2000
[15] Seidel S. Kreutzer R. Smith D. McNeel S. Gilliss D. Assessment of commercial laboratories performing hair mineral analysis. JAMA. 285(1):67-72, 2001.
[16] Harkins DK, Susten AS. Hair analysis: exploring the state of the science. Environmental Health Perspectives. 111(4):576-8, 2003
[17] Frisch M. Schwartz BS. The pitfalls of hair analysis for toxicants in clinical practice: three case reports. Environmental Health Perspectives. 110(4):433-6, 2002.
[18] Wennig R. Potential problems with the interpretation of hair analysis results. Forensic Science International. 107(1-3):5-12, 2000.
[19] Yoshinaga J. Imai H. Nakazawa M. Suzuki T. Morita M. Lack of significantly positive correlations between elemental concentrations in hair and in organs. Science of the Total Environment. 99(1-2):125-35, 1990.
[20] Klevay LM. Bistrian BR. Fleming CR. Neumann CG. Hair analysis in clinical and experimental medicine. American Journal of Clinical Nutrition. 46(2):233-6, 1987.
[21] Barrett S. Commercial hair analysis. Science or scam? JAMA. 254(8):1041-5, 1985.
[22] Eastern Research Group. Hair Analysis Panel Discussion: Exploring the State of the Science. Available at http://www.atsdr.cdc.gov/HAC/hair_analysis/. (Accessed April 21, 2003)