APPENDIX B

Charge to the Panel

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Hair Analysis: Exploring the State of the Science

The Agency for Toxic Substances and Disease Registry (ATSDR) is holding a panel discussion to review and discuss the current state of the science related to hair analysis. ATSDR has invited a cross section of scientific experts in the fields of hair analysis, toxicology, and medicine to participate in 1½ days of discussions on a variety of topics, including analytical methods, factors affecting the interpretation of analytical results, toxicologic considerations, and data gaps/research needs. The panel will discuss whether hair analysis is a useful tool in evaluating exposures to hazardous substances present in the environment. The agency will use the input received during the discussions to develop a framework for determining when measuring contaminant levels in hair can help support scientifically defensible public health evaluations.

Background

ATSDR conducts public health assessments to evaluate possible public health implications of contaminants associated with hazardous waste sites and other environmental releases. An important step in ATSDR's assessment process is examining exposures to contaminants under site-specific conditions and determining whether people are being exposed to contaminants at harmful levels. In most of the agency's evaluations, the environmental concentration serves as a surrogate for "exposure."

Exposure concentrations, or estimated doses based on exposure concentrations, however, represent only one factor in a continuum of events that ultimately determine whether exposures will result in illness. Other factors include exposure conditions and various pharmacokinetic/pharmacodynamic events (e.g., absorption, metabolism, excretion), as well as individual variability and susceptibility in the exposed population. To a large extent, ATSDR evaluates these factors qualitatively in its public health assessments.

To refine its assessments and/or to fill data gaps, ATSDR sometimes identifies ways to more precisely quantify exposures, such as measuring body burdens of a particular contaminant or its metabolites (e.g., lead in blood). On a site-by-site basis, ATSDR evaluates what additional exposure data might be practical and useful to obtain to further support public health evaluations and ultimately to help determine the disease potential of a particular exposure. *ATSDR seeks to determine the overall utility of hair analysis as one such exposure assessment tool.*

Charge to Panel Members

General Questions

ATSDR's overall goal is to receive expert opinion on the following four general questions related to hair analysis. Panelists should keep these questions in mind when answering the specific charge questions that follow.

\#   When is it appropriate to consider hair analysis in assessing human exposures to environmental contaminants?

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\#   What data gaps exist that limit the interpretation and use of hair analysis in the assessment of environmental exposures? What research is needed to fill these data gaps?

\#   For what substances do reliable hair analysis methods exist (e.g., trace elements, organic compounds)?

Specific Charge Questions

Discussions on the first day of the meeting will focus on answering questions that pertain to Topics #1, #2, and #3 below. In asking these questions, ATSDR seeks a critical review and assessment of the *state of the science pertaining to hair analysis*. The second day of the meeting will be devoted to identifying critical data gaps and research needs, and also identifying scenarios for which hair analysis should/should not be considered in light of limitations in analyzing and interpreting hair data (Topics #4 and #5).

Topic #1: Analytical Methods. Discuss/review basic sampling and laboratory methodology used in hair analysis.

\#   What analytical methods currently exist?

\#   For what substances do reliable analytical methods exist?

\#   For what purposes are these methods typically used (e.g., diagnostics, forensics, industrial hygiene)?

\#   What amount of hair is needed? Is it dependent on the substance being tested? If so, specify substance-specific requirements.

\#   To what extent are multi-element analytical approaches used? Concern: Accuracy and/or sensitivity for a specific element may be sacrificed.

\#   Intralaboratory variability: How variable are results and interpretations?

\#   Interlaboratory variability: How variable are reference ranges, results, and interpretations?

Topic #2: Factors Influencing the Interpretation of Analytical Results. Discuss to what extent (qualitatively and/or quantitatively) the following factors influence the interpretation of hair analysis data. Provide substance-specific examples. Note any additional factors not highlighted below that are critical to or limit the interpretation of hair analysis data.

\#   Variations in sample collection and preparation methods, including:

> ?   Hair sample scalp location and homogenization.

> ?   Laboratory sample preparation and washing methods.

> ?   Laboratory calibration standards and proficiency testing programs (QA/QC procedures).

> ?   "Normal" reference ranges.

> ?   "Abnormal" or "toxic" concentration ranges.

\#   Exposure of hair sample to the external environment (e.g., shampoos, bleaches, dyes, permanent waving, relaxers, styling products, hair sprays, hot dryers and curlers, tobacco smoke).

\#   Distinguishing between endogenous and exogenous sources of metals in hair.

\#   Distinguishing between exposures associated with site contamination versus exposures from typical background and other sources.

\#   Hair color, location of hair on the scalp, and hair diameter.

\#   Gender, ethnicity/race, diet, age, geographical location, and season.

\#   Rate of hair growth.

Topic #3: Toxicologic Considerations. Discuss to what extent hair analysis data can be used to predict adverse health outcomes. Cite specific examples/substances for which information is available.

\#   What is known about biological uptake of specific substances and the concentration delivered to and incorporated into hair?

\#   What is the relationship between chemical concentrations in the hair and blood compartment and target organs? For what chemicals does a correlation exist between specific chemical concentrations in other body tissues, organs, fluids, subcellular fractions, or metabolic pools?

\#   What is the dose-response relationship between chemical concentration in hair and target organ effects?

\#   Ultimately, what is the relationship between chemical concentrations in hair and disease? What is the disease-predictive value?

\#   Is information available defining "normal" ranges of chemical concentrations in hair that have physiological and health-related significance?

Topic #4: Data Gaps and Research Needs. In light of Topics #1–#3, provide recommendations to fill data gaps and overcome/clarify limitations in hair analysis and interpretation.

\#   Specify data gaps and limitations that most significantly limit the use of hair analysis in public health evaluations, both in terms of analytical methodologies and toxicologic interpretations.

\#   Identify hair analysis research needs for ATSDR's research agenda; identify specific recommendations for future studies.

Topic #5: Identifying Scenarios for Which Hair Analysis May Be Appropriate. Considering the factors identified in the matrix below, and in light of issues identified under Topics #1–#4, discuss when hair analysis *may or may not be* appropriate for evaluating exposures to environmental contaminants. This matrix will assist ATSDR in developing a framework or decision logic for determining when to conduct hair analysis.

Exposure Scenario	Chemical/ Exposure Pathway	Exposure Chronology	Exposure Duration	Measurable Health Effects (Y/N)
- *Individual* - *Community* - *Population* *(List both appropriate and inappropriate scenarios)*	*E.g., ingesting lead in soils*	*- Past* *- Present*	*- Acute* *- Chronic*	*- Specify*

Reference Materials

When addressing the charge questions, please provide citations for references that ATSDR should consider when evaluating hair analysis issues. ATSDR has developed a bibliography for your review (primarily post-1985). Please identify additional key studies or papers.

The following journal articles and papers have been provided for panelist review and consideration. ATSDR selected these papers to represent the breadth of the issues to be discussed by the panel. Their selection does not indicate ATSDR's position on any particular issue. ATSDR recognizes that these only represent a sampling of the many peer-reviewed papers on the subject of hair analysis. The purpose of reviewing these papers is to help stimulate thought and discussion related to the charge questions.

1)   Hopps H. The biologic bases for using hair and nail analyses for trace elements. Sci Total Environ. 1977; 7:71-89.

2)   Miekeley N, Dias Carneiro MTW, and Porto da Silveira CL. How reliable are human hair reference intervals for trace elements? Sci Total Environ. 1998; 218:9-17.

3)   Seidel S, Kreutzer R, Smith D, McNeel S, Gilliss D. Assessment of commercial laboratories performing hair mineral analysis. JAMA. 2001 Jan 3; 285(1):67-72.

4)   Sky-Peck H. Distribution of trace elements in human hair. Clin Physiol Biochem. 1990; 8:70-80.

5)   Steindel S, Howanitz P. The uncertainty of hair analysis for trace metals. JAMA. 2001 Jan 3; 285(1):83-85. Editorial.

6)   Wennig R. Potential problems with the interpretation of hair analysis results. Forensic Sci Int. 2000 Jan 10; 107(1-3):5-12. Review.

7)   Yoshinaga J, Imai H, Nakazawa M, and Suzuki T. Lack of significantly positive correlations between elemental concentrations in hair and in organs. Sci Total Environ. 1990; 99:125-135.