Using teeth to uncover developmental susceptibility to chemical mixtures

By Sara Mishamandani

Manish Arora, Ph.D., from the Icahn School of Medicine at Mount Sinai, presented the Jan. 13 Keystone Science Lecture Seminar Series talk at NIEHS. Hosted by William Suk, Ph.D., director of the NIEHS Superfund Research Program (SRP), Arora discussed his research on "Uncovering Early Life Exposure to Chemical Mixtures Using Micro-spatial Analysis of Teeth."

Arora is an assistant professor of preventive medicine and dentistry, and director of exposure biology at the Icahn School of Medicine at Mount Sinai. He is an NIEHS grantee and former postdoctoral trainee at the Harvard University SRP Center. (Photo courtesy of Steve McCaw)

"A good way to think of this research is to consider teeth as an encrypted hard drive," said Arora. "We are trying to break down that encryption and look at different layers of information on each tooth. Some layers give us information on environmental pollutants, others on diet. And I believe there are many more layers of information to uncover."

Understanding critical developmental windows

Although studies are making progress in better understanding the timing of exposures, Arora pointed out the difficulty of using prospective studies to link exposures to outcomes.

"For an outcome that affects one in 100, you would need about 10,000 mother-child pairs to get a sample size of close to 100 in a prospective study. One way to avoid this is to match cases to controls and look retrospectively, but then we have to reconstruct exposures leading up to the health outcome," said Arora. "Using maternal biological markers doesn't always accurately reflect fetal exposure, since different chemicals cross the placenta at different levels. This is where teeth come in."

Listen as Arora describes how much information can be found by analyzing teeth. (0:57)

Listen Now (890KB)

Transcipt (156KB)

Arora explained how mapping homeostatic disruption, the disruption of the body's internal equilibrium, in teeth can provide insight into response to environmental exposures during different developmental windows. (Photo courtesy of Steve McCaw)

Teeth start developing prenatally and carry an imprint of daily circadian rhythm, the body's internal clock. During development of a tooth, rings are formed, much like the rings of a tree. Arora's research team has developed methodology that combines detailed analysis of the layers of teeth that correspond to specific life stages. They can use this information to reconstruct exposure to individual chemicals and chemical mixtures, as well as cumulative exposure, in the second and third trimesters of prenatal development and early childhood.

Samples for these early-life exposure studies can be collected non-invasively, because most children lose their baby teeth between the ages of 6 and 13.

Linking innovative research to NIEHS priorities

Arora is particularly interested in exploring how we respond to environmental mixtures, an NIEHS priority described in a 2013 Environmental Health Perspectives editorial. *(http://ehp.niehs.nih.gov/1206182/)*

In his work using children's teeth to map early-life exposure in cohorts in Mexico and the U.S., Arora is working to better understand how chemical mixtures affect children differently. Looking at more than 10 chemicals across 50 developmental time points per individual, Arora's research team is revealing potential critical windows of susceptibility to chemical mixtures.

They are also investigating how disruptive conditions, such as stress, can change the way chemical exposures affect the body, and working toward understanding the pathways involved in disruption of normal body functions as a result of chemical, physical, and psychological stressors.

"In the past, the field of environmental health has focused on measuring exposures and linking that to an outcome, but that approach misses information about how different people respond to different exposures," said Arora. "We are looking at toxicant interactions more closely, by examining the disruptions of different pathways after exposure, based on chemical

signatures in teeth."

Arora touched on some of his recent innovative findings related to chemical distributions in teeth, such as a May 2013 study *(http://www.ncbi.nlm.nih.gov/pubmed/23698370)*
published in the journal Nature.

(Sara Mishamandani is a research and communication specialist for MDB Inc., a contractor for the NIEHS Superfund Research Program and Division of Extramural Research and Training.)

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