

Emerging Issues

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Committee on Emerging Issues and
Data on Environmental Contaminants

Communicating Toxicogenomic Information to the Public

“It’s a fool’s errand to rush into any new scientific venture without considering the implications of the research,” Mark Rothstein said as he introduced an April 22, 2004, workshop on Communicating Toxicogenomic Information to Non-Experts, sponsored by the National Academies’ Committee on Emerging Issues and Data on Environmental Contaminants. Mr. Rothstein, a committee member from the University of Louisville, explained that with the science of genomics focusing on ever smaller components of biological systems, the challenge for scientists and the public is to see the big picture and to appreciate the societal implications of these new technologies. Critical to seeing the big picture is an understanding of how toxicogenomic information is communicated to the public and what the public wants and needs to know about the science.

Effective communication must be based on an understanding of the audience for the information as well, emphasized Robert Griffin, a committee member from Marquette University. (See related article by Dr. Griffin later in this newsletter.) There is often a considerable difference between what people want to know about a scientific subject and what scientists think the public needs to know. The focus of any communication strategy, and of this workshop, was how the average person might encounter toxicogenomic information and then use it for making decisions about his or her life.

The workshop consisted of two panels of presenters: a morning session that explored the impact of communicating toxicogenomic

information on individual decision-making; and an afternoon session that focused on its impact on societal decision making. In order to ensure that all workshop participants and the audience had a basic understanding of toxicogenomics, William Greenlee, a committee member from the CIIT Centers for Health Research, gave a short primer on the science. He explained the basis for the new toxicogenomic technologies, such as microarrays, and what is meant by the “omics” revolution.

Dr. Greenlee’s presentation was followed by the first of the morning panelists, Sharon Dunwoody, University of Wisconsin-Madison, who provided an overview of some of the science communication issues that would be covered by the panels. Dr. Dunwoody began with what she called the “biggest risk communication mistakes made by scientists.”

continued on page 3

IN THIS ISSUE

- 1 *Communicating Toxicogenomic Information to the Public*
- 2 *Genomics Implications for EPA Applications*
- 5 *Different Audiences Hear Different Messages*
- 7 *Agenda for August 12 Workshop*

Genomics Implications for EPA Regulatory and Risk Assessment Applications

By Kerry L. Dearfield, Ph.D. and William H. Benson, Ph.D.
U.S. Environmental Protection Agency

The Environmental Protection Agency (EPA) issued its *Interim Policy on Genomics* in June 2002. The policy acknowledges that genomics data and analyses will significantly impact many areas of scientific research as well as human health and ecological assessments. Further, the interim policy encourages prudent and beneficial use of genomics information by EPA on a case-by-case basis. EPA hopes that consideration of genomics information will ultimately improve the Agency's risk assessments. However, before this information can be fully used in many Agency applications, there are challenges that need to be addressed.

At the request of EPA's Science Policy Council, a Genomics Task Force comprised of Agency staff was formed to examine these potential applications and challenges. The Task Force was specifically charged with examining the broad implications that genomics is likely to have for EPA programs and policies, in an attempt to better understand the appropriate use of these data and the potential consequences of their use, as well as to identify possible infrastructure needs. The group was also charged with developing scenarios to describe various circumstances under which EPA might receive these data. The resulting draft white paper (see box on page 3) presented the implications of using genomics technologies in EPA practice, for the consideration of Agency managers. Recently,

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this draft white paper was externally peer reviewed, and it is currently being finalized to reflect reviewer comments.

Four applications were identified in the draft paper as likely to be influenced by the generation of genomics information within EPA and the submission of such information to EPA. (1) *Prioritization of contaminants (chemicals and microbes) and contaminated sites*: There are a large number of stressors that EPA must prioritize for further evaluation, such as those for its High Production Volume Challenge Program for industrial chemicals and its Contaminant Candidate List for drinking water pollutants. Genomics may provide a means to develop a more mechanistic, molecular-based approach for prioritization. (2) *Monitoring*: EPA uses site-specific and media-specific data to make regulatory decisions, monitor compliance, and to determine the state of the environment. Much of these data could be generated by genomics-based techniques, e.g., for microbial source tracking. (3) *Reporting provisions*: Once the challenge of determining adverse effects using genomics techniques has been met, EPA will need to consider whether these genomic-based data will be subject to Agency reporting provisions for adverse effects. (4) *Risk assessment*: Genomics technologies and information will ultimately enhance EPA risk assessments, likely by delineating a stressor's mode of action. Although genomics will not fundamentally alter the risk assessment process, it is expected to serve as a new, more powerful tool for evaluating exposure to and effects of environmental stressors.

In addition to the four applications of genomics data listed above, the Task Force also identified three overarching challenges to genomics: research, technical development, and capacity. The Agency

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Genomic Implications for EPA

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must meet these critical needs to strengthen its ability to use genomics information in a meaningful way, and to address potential regulatory applications. For *research*, the critical needs included: (1) linking genomics information to adverse outcomes; and (2) interpreting genomics information for risk and hazard assessment. It is important to note that significant research by EPA and other agencies and researchers will be necessary to fully understand and apply genomics technologies to human health and ecological risk assessments. A critical need for *technical development* is establishing a framework or criteria for analysis and acceptance of genomics information for scientific and regulatory purposes, including data quality standards based on genomic assay performance. Two critical needs were

The Interim Policy on Genomics and the draft white paper “Potential Implications of Genomics for Regulatory and Risk Assessment Applications at EPA” are available on the EPA Office of the Science Advisor web site at: www.epa.gov/osa

identified with respect to *capacity*, including human capital: (1) applying strategic hiring practices to recruit individuals who possess “genomics core competencies” essential for the crucial areas of research, analysis, systems biology, bioinformatics, and risk assessment; and (2) training EPA risk assessors and managers to interpret and understand genomics data in the context of a risk assessment.

The Agency recognizes that it must be proactive in identifying, developing, and standardizing applicable genomics approaches. It is essential for EPA to continue to collaborate with other federal agencies, academia, the regulated community, and other stakeholders in this endeavor in order to benefit from ongoing advances in genomics in the wider scientific and regulatory communities. ○

Communicating Toxicogenomic Information

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These included the notion that a scientific expert is the best person to explain risks to a general audience and that the more an individual knows about a technology the more he or she will appreciate it. She explained that risk perception is based on more than factual information, and includes the perceived benefits from and familiarity with the risk.

David Ropeik, Harvard University, began his talk with a hands-on demonstration of how people learn and the impact that their first impression of a situation can have on subsequent encounters with similar situations. This “framing” of knowledge is very important, and scientists and others need to appreciate that individuals have different emotional and cognitive frameworks by which they integrate new information. He stressed that because most

people are not familiar with toxicogenomics, this is the ideal time to start framing the issue for people. Mr. Ropeik questioned the term “toxicogenomics” itself, and said that such a long and complicated word may seem threatening to the public.

Communication should focus on helping people make informed decisions, emphasized Julie Downs, Carnegie Mellon University, and there must be an integrated approach to conveying scientific information that involves scientists as well as other experts. Once these experts know how people perceive an issue and know their level of science education, the scientific message can be framed more effectively. Scientists must be aware that a naïve audience may tend to use less reliable information, and that the Internet is the primary source of

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Communicating Toxicogenomic Information

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this information. Following Dr. Downs, Craig Trumbo, University of Vermont, discussed several concepts that should be kept in mind when communicating about risk. These include “intuitive toxicology,” i.e., a person’s belief that a substance is either safe or unsafe, and “popular epidemiology,” where the public raises concerns about diseases. Dr. Trumbo suggested that some of the confrontational aspects of these concepts may be avoided by early public involvement. He explained that risks that are internal or voluntary for an individual are more readily accepted than those imposed from external sources.

The afternoon presentations focused on communication about the potential societal impacts of toxicogenomics and how various audiences might respond to this new area of technology. William Freudenberg, University of California, Santa Barbara, stated that risk does not exist in a vacuum. He posed three questions that scientists need to think about: How safe is it? Is that safe enough? And finally, what are we missing? He noted that scientists must consider the legacy of past technological development on toxicogenomics and the potential interests of organized groups.

Dr. Freudenberg was followed by Deirdre Lawrence, National Cancer Institute, who stressed that risk communication must take into consideration how disparate populations may use information to make health decisions. These population differences may be based on a number of factors including income, ethnicity, occupation, and gender. She questioned whether more information about potential susceptibility (based on genetic or other information) to an environmental hazard would actually affect a person’s health decisions. Building on Dr. Lawrence’s discussion

of health disparities among audiences, Kasisiomayajula Viswanath, Harvard University, described some of the social factors that result in communication inequality. These factors, including income, education, and access to the Internet, will influence how an audience perceives information and what they do with it. Dr. Viswanath said scientists need to appreciate that there is a social construct to risk; that is, different groups define risk differently, and those definitions may reflect advocacy, politics, or other perspectives.

Susanna Hornig Priest, Texas A&M University, posited that public opinions about a risk may be more influential than scientific definitions, as demonstrated by public reaction to genetically modified foods. Furthermore, public opinion is more influenced by trust than by knowledge, so just communicating facts may not encourage public acceptance. She acknowledged that although the public needs to be involved early in policy development, for new technologies such as toxicogenomics, there is as yet no scientific agreement about what the public should know. Lastly, Dr. Priest explained that engaging the public in meaningful debate and constructive reflection is not an approach at which the United States is adept.

At the end of the panel discussion, the panelists participated in an open dialogue with the audience. The panelists expressed a view that toxicogenomic researchers must keep in mind the “So what?” question. That is, they must begin by defining what value and impact toxicogenomics research will have for the public. Once the message is framed, risk communicators can then start planning how and what toxicogenomic information should be communicated to various audiences including minorities, policy makers, and even other scientists.

Do you want more information? Please visit our website at <http://dels.nas.edu/emergingissues/index.asp> where we have presentations from previous workshops and meetings, agendas for upcoming meetings, a current list of committee members, and other items of interest.

Different Audiences Hear Different Messages

By Robert J. Griffin, Ph.D.
Marquette University

A lot of risk communication research and practice is still framed by a classic model developed by Harold Lasswell in 1948. He tried to spotlight the noteworthy components of the communication process through a set of salient questions:



- Who (source)?
- Says what?
- To whom (receiver)?
- Via which channel?
- With what effect?

This framework, and others like it, emphasized communication from the viewpoint of the sender of the message, in particular one who was primarily interested in crafting targeted stimulus messages to strategically lever changes in an audience's attitudes and behaviors. In terms of risk communication, this approach frames the task as one of transmitting technically-based information from an expert, scientific source to a lay (i.e., non-expert) audience in a way that typically exhorts people to adopt risk-reducing changes in their behaviors (e.g., to stop smoking), often by trying to get them to see things the way the experts do. Although this may be a noble goal, the net result is to lob information at audiences, not communicate with them, and failure is the all-too-typical result.

In contrast to this framework is the audience-centered approach to risk communication that asks risk communicators to consider seriously what it is like to be a lay receiver of risk and related scientific

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or technical information, especially through channels such as the local newspaper, television, Internet sites, pamphlets, and so forth.¹ Or, as communication scholar Steven Chaffee said, we also need to consider:

- Who (receiver)?
- Hears what?
- From whom (source)?
- Via what channels?
- For what purpose?²

Rather than simply concentrating on how a stimulus message might engender a desired response (e.g., an effect on how people feel or act), communicators who adopt an audience-centered approach consider the audiences for their information as empowered and often active participants in the communication process. In this approach, risk-related information is not seen as altering behavior through some clever psychological gimmick but rather as knowledge offered to individuals to use for their personal risk decisions or to consider in public policy decisions.

Thus, when applying what has been learned from communicating about risk to communicating about toxicogenomics, communicators may need to put on a different set of goggles. We will need to view communication in terms of what we are *offering* (not just *sending to*) the various audiences for toxicogenomics information, each of which consists of individuals with different interests, abilities, and informational needs. The information needs to be offered in such a way that they will choose to pay attention to and seriously consider it. For example:

- What information do different groups of people say they need to help them make a decision?

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Different Audiences Hear Different Messages

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This could be quite different from what experts think they need.


- What opportunities do various segments of society have to access and understand the information? For example, the people who are the easiest to reach with our message may not be the ones who need to hear it the most, and vice versa.

- How will different audiences assess the value of the channel they use to gather the information and how will they assess the value of the information in the message itself? We, as communicators, usually want audiences to think carefully about the risk messages we are giving them. However, the reality is that the more that an audience member actively engages what we are saying, the more likely that he or she will also think critically about it, and the more likely that he or she will be affected by the message in a different way than we might anticipate.

Much of the risk communication research discussed during the workshop (see lead article), demonstrates the challenges that risk communicators often face. As you think about how to communicate toxicogenomics information, please keep an audience-centered approach in mind. The chances of making a deep, long-lasting impression on audiences by relying on simple, mass-media delivered messages are virtually non-existent.

Notes:

1. For valuable background, see two National Academies Press publications in particular: *Improving Risk Communication* (1986, 2000) by the National Research Council's Committee on Risk Perception and Communication, and *Understanding Risk: Informing Decisions in a Democratic Society* (1996) by the NRC Committee on Risk Characterization, edited by P.C. Stern and H.V. Fineberg.

2. For elaboration see S.H. Chaffee's (1986) Mass media and interpersonal channels: Competitive, convergent, or complementary? In G. Gumpert and R. Cathcart (eds.), *Intermedia* (3rd ed.), New York: Oxford University Press. 

ITEMS OF INTEREST

“The Environmental Genome Project Phase I and Beyond” by Samuel H. Wilson and Kenneth Olden (NIEHS) in *Molecular Interventions*, 2004, 4:147-156 (abstract available at <http://molinterv.aspetjournals.org/cgi/content/abstract/4/3/147>). This article describes the Environmental Genome Project (<http://www.niehs.nih.gov/envgenom/home.htm>) initiated by the NIEHS in 1998. In particular, it discusses the EGP candidate gene approach to systematically identify and characterize human genetic polymorphisms in selected genes that are potentially involved in susceptibility to environmentally induced disease. Also discussed are the GeneSNPs database, two EGP case studies, and projects studying the SNP distribution in subpopulations and functional significance of human genetic polymorphism.

In the May 2004 issue of Environmental Health Perspectives: Toxicogenomics (<http://ehp.niehs.nih.gov/txg/docs/2004/112-7/toc.html?section=toxicogenomics>)

- Comparative genomics work at Duke University, part of the NIEHS Toxicogenomics Research Consortium
- Metabolomics—the comprehensive and quantitative study of metabolites
- Overview of a conference on bioinformatics application to enhance understanding of how cells and organisms respond to toxins

This newsletter as well as additional information about the committee and its activities can be found at <http://dels.nas.edu/emergingissues>.

The newsletter of the Committee on Emerging Issues and Data on Environmental Contaminants, “Emerging Issues in Environmental Health Sciences,” is published to keep you informed of committee activities. This is a joint project of the National Research Council's Board on Environmental Studies and Toxicology and Board on Life Sciences. The views expressed in the articles in this Newsletter are those of the individual authors and do not reflect the findings or conclusions of The National Academies.

Applications of Toxicogenomics to Cross-Species Extrapolation: A Workshop

THURSDAY, AUGUST 12, 2004
(9:00 AM to 5:00 PM)

William Benson, U.S. Environmental Protection Agency
Regulatory Issues in Cross Species Extrapolation

John Butenhoff, 3M Corporation
**Species Differences in Response to
Perfluorooctanoic Acid**

Richard Di Giulio, Duke University
**Highlights from a Recent Pellston Workshop on
Emerging Molecular and Computational Approaches
for Cross-Species Extrapolation**

Donna Mendrick, Gene Logic
**Modeling Gene Expression Data to Predict Human
Hepatotoxicity Following Inconsistent Animal
Responses**

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If you cannot attend the
workshop, you may
listen via a live audio
webcast at
<http://national-academies.org>.

Stephen Nesnow, U.S. Environmental Protection Agency
**A Transcriptional Analysis Approach to Understanding
the Basis of Species Differences in Conazole
Toxicology**

Susan Sumner, Paradigm Genetics
**Using Metabolomics/Omics to Explore Species
Differences in Metabolism and Distribution**

Russell Thomas, CIIT Centers for Health Research
**A Systems Biology Approach to
Cross-Species Extrapolation**

Frank Witzmann, Indiana University
**Technological Challenges of Cross Species
Extrapolation Using Proteomics**

Roundtable Discussion of Issues

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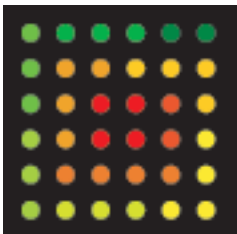
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An Invitation to **APPLICATIONS OF TOXICOGENOMICS TO** **CROSS-SPECIES EXTRAPOLATION:** **A WORKSHOP**

THURSDAY, AUGUST 12, 2004

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