FEATURE

Partnership in research: Exposure assessment methods

The National Institute for Occupational Safety and Health (NIOSH), under the leadership of Dr. Linda Rosenstock, in conjunction with several partners and stakeholders, created and is implementing the National Occupational Research Agenda (NORA), a framework to guide occupational safety and health research into the next decade. NORA is actually a multitiered partnering agenda. This paper will address NORA in general and then, within the context of NORA, delve more deeply into the workings of one of the partnership teams, Exposure Assessment Methods.

By M. L. Woebkenberg

NORA, as a concept and a process, is the first layer of partnership. In addition to NIOSH, over 500 individuals and organizations from outside of NIOSH partnered to develop the concept. The concept embodies 20 partnership teams addressing 21 priority research areas. Each team is a functioning partnership. This paper will focus on the Exposure Assessment (EA) methods team.

The NORA Exposure Assessment methods team, like all NORA teams, comprises representatives of NIOSH, other government agencies (DOE and DOD), industry (Exxon Biomedical Sciences, Inc., Occidental Chemical Co.), labor, academia (University of North Carolina, George Washington University), and professional societies such as the American Conference of Governmental Industrial Hygienists.

***Dr. Woebkenberg** is currently serving as the Deputy Director of the Division of Biomedical and Behavioral Science at the National Institute for Occupational Safety and Health. She is the Chair of ISO TC146/SC2 on Workplace Atmospheres, a member of ASTM D22, ACS, the Air Sampling Instrument Committee of ACGIH, and editor of Instrument Performance Criteria in the* Applied Occupational and Environmental Hygiene *Journal.*

The team is truly the second layer of partnership within NORA. Aspects of partnership can be seen in team composition, team dynamics, and team products.

The goals of this team include:

- Future research and resources for new topics in EA
- Directing and focusing occupational safety and health research on EA
- Facilitating collaboration and coordination
- Establishing and developing broad-based and lasting partnerships

To accomplish these goals, the first task was to grapple with the concept of EA. Many disciplines within the occupational health community conduct types of EAs. These disciplines run the gamut from psychologists to engineers. As a result of this diversity, the team attempted to define EA, offering inclusive definitions wherein each discipline could read the same words and apply them. The team provided the following definitions as an attempt at harmonizing the approach to the field of EA.

The definition of Exposure Assessment (EA) is the application of a body of knowledge to determine the relevant characteristics of one or more agents in an environment, which poses health risks to workers. These agents can be chemical hazards, biological hazards, physical agents, or human factors like stressors, or a combination of hazards.

The process of occupational EA includes identifying and characterizing workplace exposures, evaluating their significance, and developing estimates of exposure for individual or groups of workers which may be used in risk assessment or exposure-response studies. This assessment process may be formal, in which a hypothesis is tested, or informal, in which one or more characteristics of the exposure environment are measured and evaluated.

Additional definitions that are helpful in understanding EA are:

Hazard identification: establishing the existence of a hazard through field observations and/or laboratory analysis of the exposures and/or adverse health effects.

Exposure characterization: describing the qualities of a given environment, such as the magnitude, frequency, duration, and physical properties of an exposure, the potential for contact with the human body, and the toxicity related to its chemical form or physical state.

Exposure Evaluation: Determining the significance of an exposure relative to known or perceived risks.

Exposure Estimation: Developing an approximate exposure value for an individual or a statistical distribution of exposure values for groups of workers exposed to similar conditions.

The fourth term, exposure estimation, has been used traditionally in retro-

1074-9098/00/$20.00
PII S1074-9098(99)00071-4

spective epidemiologic studies, job exposure matrices development, and risk assessments. Thus, the definition has fairly specific, as well as statistical, connotations and usage.

The team put forth the definitions because it became necessary to get a "handle on the elephant" before we cut it into bite-sized pieces. The definitions allowed the team to move forward, producing other team products. These products include support and/or cosponsorship of symposia and workshops on EA and development of a White Paper. The team cosponsored an Applied Workshop on Occupational and Environmental Exposure Assessment with the American Conference of Governmental Industrial Hygienists in 1998. Team members were also on the planning committees of two conferences: the National Institute of Environmental Health Science/National Toxicology Program Workshop, The Role of Human Exposure Assessment in the Prevention of Environmental Disease, held September 22–24, 1999, in Rockville, Maryland, and the International Symposium on Occupational Exposure Databases and Their Application for the Next Millennium held October 31–November 3, 1999, in London.

The White Paper took form as 104 research needs and opportunities were grouped into 4 major categories: study design, EA methods, toxicology, and education.

The White Paper began when the team brainstormed research needs and opportunities in EA. In addition to the team's expertise in the following disciplines: chemistry, biology, industrial hygiene, toxicology, occupational health nursing, epidemiology, and physics, we invited representatives from other disciplines, such as occupational medicine, and physical agents to provide input to the team and review the output.

The White Paper took form as 104 research needs and opportunities were grouped into 4 major categories: study design, EA methods, toxicology, and education.

The study design section recognizes that the success of any EA is fundamentally a function of the study design and its inherent sampling strategy. Whether the study is to characterize multiple facets of current occupational exposure, evaluate compliance, assess an engineering control, or construct estimates of historical exposure, a well-designed study is scientifically defensible, produces valid data, leads to a better understanding of disease, and results in improved public health.

An example issue in the study design section is:

- Data Quality—There are documents and publications that relate to the development of practical EA tools. However, there is no single document to reference as standard practice. As a result, data are collected and maintained in a variety of ways that can be incompatible with each other. To address this the team is recommending development of a practical EA guide, perhaps with accompanying software for managing and maintaining such data.

The study design section of the White Paper also looks at issues in data collection, data management, and data analysis.

The monitoring method development section recognizes that measurement tools, both methods and instruments are fundamental to EA. It addresses environmental, biologic, psychosocial, and ergonomic methods. Of particular importance is the development of guidelines for the development and evaluation of measurement methods. Measurement method guideline documents are needed for direct-reading instruments, diffusive samplers, dermal exposure methods, and biologic monitoring methods. Such guidance documents specify the experimentation required for determining figures of merit for a technique such as method accuracy, the experimentation needed to verify performance under extreme conditions, the calculations needed, and the criteria to be met.

The toxicology section addresses understanding the underlying toxicologic relationships, such as those between workplace exposure, internal dose, target-organ dose, preclinical effects, and clinical effects. Understanding these relationships is fundamental to EA. The research needs suggested in the White Paper such as more research to ascertain the mechanisms of chemical, physical, and biologic agents, and the development of a toxicity assessment protocol with guidelines for a systematic approach to estimating exposure limit, bear this out.

Measurement method guideline documents are needed for direct-reading instruments, diffusive samplers, dermal exposure methods, and biologic monitoring methods.

Finally, the White Paper contains a section on education and communication. This may seem somewhat misplaced in a document on EA methods prepared as part of a national research agenda. However, the EA methods team feels that good research comes from well-prepared researchers. The team does make some recommendations with regard to education, both formal classroom training and the use of fellowships directed at EA.

The paper will be published as a NIOSH document in FY 2000. The

team hopes that many will have an opportunity to consider the paper's content and return feedback. Team outputs such as White Papers, workshops and symposia, are a third layer of partnership within NORA.

A fourth layer of NORA partnering includes intramural and extramural research opportunities. During the last two years, NIOSH has partnered with other federal agencies to cofund grants in certain NORA priority research areas. In FY99, EA methods was one of the research priorities highlighted in the request for grant applications. The grant applications are currently under review.

NIOSH is also considering criteria and options for cooperating with non-Federal partners. The EA team, along with other NORA teams, has participated in discussions with the Chemical Manufacturer's Association (CMA). Areas of potential cooperation and common interest include:

- Macrolevel identification of where, and to whom, exposures occur
- Dermal exposure and bioavailability

In its White Paper, the EA methods team recommends development of new job exposure matrices, creation of an on-going National Occupational Exposure Survey, development of a National Occupational Exposure Database, and updating the NIOSH Occupational Exposure Sampling Strategy Manual. All of these will help in identification of where exposures are occurring and identify who is being exposed.

On the dermal issue, NORA has a very active Allergic and Irritant Dermatitis Team. The EA methods team has also made recommendations for increased research in dermal exposure assessment.

The EA methods team recommends development of new job exposure matrices, creation of an on-going National Occupational Exposure Survey, development of a National Occupational Exposure Database, and updating the NIOSH Occupational Exposure Sampling Strategy Manual.

As you can see, NORA is a multitiered partnership in research. We have identified four levels of partnership:

1. NORA, itself (NORA as a partnership process is unique)
2. The NORA teams (20 teams dedicated to further developing and implementing the research agenda)
3. Team Outputs (Conferences, White Papers)
4. Outreach Activities (Facilitating collaboration and coordination of research)

This begs the questions: what should be done now? What does the future hold? There are many considerations to answer these questions.

- Now is the time to see that the research identified in the agenda is actually carried out. The agenda is a *national* research agenda, not just a menu from which NIOSH selects its projects. The idea of NORA is for all the partners to pool resources and maximize the return on investment for all concerned. This is where our team goals of facilitating collaboration and coordination, and establishing and developing broad-based and lasting partnerships come into play.
- The agenda, by its very nature, is neither static nor fixed. It is a work in progress. As research products are developed and move off the agenda, new research needs and priorities emerge
- NORA has had a profound effect on NIOSH and its partners. It has, indeed, changed the way business is done. Each reader is invited to investigate becoming a partner in research. Please visit the NORA Web site on the NIOSH home page at: http://www.cdc.gov/niosh/norahmpg.html.