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Risk assessment's New Era: Part 1: Challenges for Industrial Hygiene

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Risk is an inherent aspect of our lives. Whether the topic is the nation's dietary habits, community air pollution or chemical exposures in the workplace, risk analysis is an integral part of the conversation.

Risk analysis is the combined activities of assessing, managing and communicating human health risks. Interest in understanding risk from chemical exposures and other stressors has led to the formalization of health risk assessment as an applied public health science. Numerous seminal reports from the National Academies of Science (NAS) have highlighted the framework for risk assessment and risk management, as well as key changes within the practice of risk analysis.

The profession of industrial hygiene has evolved to reflect the changes in health risk assessment methodology and practice. Traditional industrial hygiene practice−the anticipation, recognition, evaluation and control of occupational and environmental hazards and risks–parallels key aspects of health risk assessment. Thus, industrial hygienists have a strong history as leading practitioners of all aspects of risk analysis–health risk assessment, risk management and risk communication–within the occupational environment.

Risk analysis methods and tools are important resources for articulating scientific knowledge to those who make decisions regarding public and occupational health. Just as we need to stay attuned to developments in the latest air sampling techniques, keeping current on risk analysis is equally essential.

As the field of risk analysis expands, emerging techniques will be valuable for practicing industrial hygienists. Examples include:

- tools for addressing aggregate risk from single agents yet multiple environments (for example, work, home, car, air) and cumulative risks from multiple stressors

- a more thorough incorporation of cost-benefit analysis and life cycle impacts on occupational exposures for a better understanding of the economic impacts of risk management decisions
- improved techniques for studying how perceptions affect the acceptability of a particular risk

Driven by advances in science and technology, these new risk analysis methods are allowing health professionals, including industrial hygienists, to tackle ever more complex problems and make more informed decisions. For industrial hygienists, this new era offers several opportunities. Mastery of risk analysis tools is one of our core competencies; staying ahead of the curve will serve occupational and public health well and increase our value.

With this vision in mind, AIHA sponsored the 8th Risk Assessment Symposium as part of the Professional Conference on Industrial Hygiene (PCIH) in Baltimore this past November. The Symposium highlighted innovations that are fundamentally changing the practices of risk assessment, risk management and risk communication.[1] Speakers at the Symposium represented experts in the fields of industrial hygiene, toxicology, occupational health and risk assessment from academia, industry and the public sector.

Over the next few months, a series of articles in *The Synergist* will describe the key concepts presented during the Symposium. This article, the first in the series, identifies the main challenges facing industrial hygienists as we enter the new era of risk assessment.

Reducing Uncertainty

Uncertainty is inherent within a risk assessment.[2] If a dangerous condition exists with little or no uncertainty, there is no reason to assess risk; one moves directly to controlling the hazards. Thus, risk assessments must consider uncertainty during every phase of the process.

Uncertainties exist in the identification and measurement of hazards, the estimation of exposures, the identification and measurement of health effects associated with exposures, and the method used to characterize population and operational risks. Creating a risk assessment is an iterative process designed to be refined until there is consensus on the most important and most uncertain factors affecting the results. How confident do decision makers need to be regarding these important but uncertain factors? The answer to this question should determine the duration and complexity of the risk assessment. Perceptions of risk and the availability of data influence estimates of health risk.

A major criticism of the risk assessment process concerns the impact of uncertainty on the accuracy and usability of the findings. Uncertainty can be thought of as absence of knowledge on a specific issue, such as the toxicity or physiochemical properties of a substance, or the distribution of exposures among a group of factory workers. One way to reduce the impact of uncertainty is to include data within each step of the risk assessment. The need for robust sources of scientific data is a challenge that must be overcome to ensure accurate, usable results.

Fortunately, promising scientific advancements may help reduce uncertainty. For example, new toxicity testing methods under development might offer quicker and less expensive alternatives to traditional bioassays. A groundbreaking 2007 NAS report outlined a framework for the continued development and use of alternative testing methods that aligns with the traditional risk assessment paradigm[3] and generates data needed to reduce uncertainty within the hazard identification and dose-response steps of a risk assessment. This information will help characterize chemicals' properties and metabolism, define key exposure pathways, and identify potential human effects of exposure. These new sources of data will greatly enhance industrial hygienists' ability to conduct effective occupational and environmental assessments. The challenge lies in understanding and applying the new data to reduce the impact of uncertainty within the risk assessment process.

Shifting from Traditional Health End Points

What health end point should serve as the focal point for an occupational risk assessment? Should transient reversible or subclinical health effects be regulated to the same level as irreversible effects, such as cancer?

These questions are frequently debated among health professionals, stakeholders and regulators. A review of the documentation of available occupational exposure limits (OELs) quickly demonstrates that a large majority of the health-based recommendations focus on irreversible health end points, such as cancer, neurotoxicity or reproductive effects. Advances in science and medicine now allow us to identify subclinical effects, such as genetic and immune responses to certain chemical agents, that have not been considered during the derivation of OELs. For example, consider the effects of enzymes that metabolize occupationally relevant toxicants. Many genes that code for these enzymes are polymorphic–that is, the genes vary from person to person, resulting in different responses. In theory, a subpopulation of workers might exhibit greater susceptibility to the toxic effects of a chemical and, therefore, require additional protection. In the case of dichloromethane, researchers have found that examining genetic data reduced the unit risk by a factor of more than 100 from previously published risk assessments. The degree to which genetic polymorphisms increase human variability in toxic response is widely discussed, but so far, such variability has been poorly characterized.

Genetic data may also prove useful in addressing uncertainties in cross-species and other extrapolations. It remains to be seen how useful the genetic data being accumulated now will be to 21st century risk assessment, but it's clear that integrating genetic information into risk assessment will be an exciting new challenge.

Another emerging practice, cumulative risk assessment, assesses the combined risks associated with multiple stressors on human health. This goes beyond determining the impact of exposures to a single agent via multiple pathways, such as inhalation, dermal and oral; it attempts to determine the role of numerous agents on the development of a disease.[4] Cumulative risk assessment shifts the attention for a single stressor, such as a chemical, to multiple stressors. Although industrial hygienists are familiar with the need to account for multiple exposure pathways, assessing multiple stressors is a new concept that poses

numerous challenges. For example, how do we control a specific hazard within the workplace when a cumulative risk assessment reveals that non occupational factors (for example, contaminated waters, prescription medication and dietary habits) are increasing the risks of health consequences for workers? Clearly, industrial hygienists need to consider nontraditional exposure scenarios with a focus on the pathways, sources and agents.

Emerging Hazards

Industrial hygienists are all too familiar with the challenges that arise when emerging technologies are introduced into the workplace. These novel hazards might stem from new molecules or processes, old molecules used in new ways or non chemical stressors.

The best example of new molecules that are impacting our world may be engineered nanomaterials, which in recent years have been integrated into an infinite number of commercially available products. The new molecules under development to comply with the need for sustainability are another example. The data available on the toxicity of these chemicals are often limited, and the health risks to humans are unknown. New uses of molecules traditionally identified as safe may result in hazardous conditions not previously characterized (flavoring compounds, for example). The last type of emerging hazards focuses on nonchemical stressors, such as shift work, which the International Agency for Research on Cancer recently identified as probably carcinogenic to humans based on disruption of the body's biological rhythms.[5]

What health risks do these emerging hazards pose to workers, the environment or consumers? How do industrial hygienists develop risk management policies to protect workers when limited data are available on these hazards? These questions aren't easy to answer.

Meeting the Challenge

Industrial hygienists are uniquely qualified to participate in the evolution of the risk assessment process due to the multidisciplinary nature of the profession and our long history as risk assessment professionals. And because of our training and education in the physical and biological sciences, public health, engineering and management, we have a perspective not shared by other, more specialized professions. We are therefore well placed to take the lead in developing methods of risk analysis (risk assessment, risk management and risk communication). A proactive stance will ensure that new technologies and approaches in the risk sciences can address the challenges posed by the occupational environment.

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