The Scientific Bases Of Cancer Chemoprevention: Proceedings Of The International Forum On The Scient

Environment and health:
9. The science of risk assessment

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Potential hazards surround us at home, in the workplace, in our cars and even in health care facilities. Given exposure to these hazards, we may want to evaluate the risk that an adverse event will occur or that it will occur at some level of severity. In this article we introduce some concepts about risk and how it can be assessed, comment on the nature of hazards and the uncertainties inherent in the risk assessment process, and show how risk assessment affects the management of these hazards. Most of our discussion is in terms of chemical carcinogenesis, but the principles apply to the full range of threats to human health and survival.

Scope of risk assessment

A committee of the US National Academy of Sciences proposed a model in 1983[1] that is now commonly used to discuss the assessment of occupational and environmental hazards. Others, such as the National Research Council,[2] have elaborated and refined this model. The basic model, which we use here, partitions risk assessment into 4 steps: hazard identification, dose–response modelling, exposure assessment and risk characterization. Integration of a risk assessment with a cost analysis and other matters to develop strategies for risk regulation and control is often called "risk management."

Numerous scientific and technical disciplines are involved throughout a risk assessment. Hazard identification uses the input of biologists, chemists and others to determine whether available data indicate that some compound or exposure should be considered a possible "hazard," and epidemiologists are needed to evaluate the strength of human studies, especially in attempts to determine whether an association between exposure and an adverse response is one of cause and effect. Dose–response modelling requires the input of statisticians, epidemiologists and people expert in developing models that predict adverse response as a function of dose. Pathologists provide additional background on the nature of the adverse response, toxicologists are especially important for understanding mechanisms of toxicity and the relevance of animal data for human exposures, and bacteriologists may be critical in elucidating the spread of an infectious disease. Exposure assessment often requires the input of engineers as well as hydrologists (for waterborne hazards), meteorologists (for airborne hazards) and analytical chemists. Industrial hygienists can be critical in providing insight into current and past occupational and environmental exposures; this insight may also be relevant to levels of exposure to the general population. The characterization of risk may involve all of these disciplines and many others.

Given the broad array of possible hazards of modern life and the complex issues raised by their assessment and possible control, it is no surprise that risk assessment, especially of chemical hazards, is difficult, plagued by uncertainty and often controversial. A major risk assessment (of lead, for example, or dioxin) can cost millions of dollars and require vast amounts of scientific talent. The need for reliable data of many kinds is enormous. Versions of the criteria of Hill[3] for inferring causality in epidemiology are important in this regard. These criteria include an appropriate temporal pattern, with exposure preceding response; a relation between increasing dose and increasing response; and the detection of the response across multiple studies conducted in different ways and in different populations. However, these criteria are not always appropriate. Epidemiological studies may show an increase in the frequency of a congenital abnormality as exposures rise, but a decrease in frequency at even higher doses because affected fetuses have such severe problems that most die in utero and cannot display the abnormality.

Review
Synthèse

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