

NOTICE: This material is to be  
protected by copyright law  
(Title 17, United States Code).

## COMMENTARY

## The Discipline of Toxicology

ROBERT A. NEAL\* AND JOHN DOULL†

\*Center in Molecular Toxicology, Department of Biochemistry, Vanderbilt University School of Medicine, Nashville, Tennessee 37232; and  
†Department of Pharmacology, Toxicology, and Therapeutics, University of Kansas Medical Center, Kansas City, Kansas 66103

Received October 12, 1994

The Discipline of Toxicology. NEAL, R. A., AND DOULL, J. (1995). *Fundam. Appl. Toxicol.* 24, 151-153. © 1995 Society of Toxicology.

Will toxicology ever become recognized as a rigorous scientific discipline similar to other biological sciences such as biochemistry or pharmacology? Clearly the quality of research published by some toxicologists is equal to that in other biological science disciplines. However, in general, toxicology is not recognized as an academically rigorous specialty. This is, in part, because a number of the activities currently associated with the discipline of toxicology do not employ standard principles for interpreting scientific data. Foremost among these activities is risk assessment as currently practiced by various organizations, including federal, state, and local government agencies. In addition, unlike any other organized scientific discipline, toxicology has attracted a number of special interest groups whose concern is not primarily scientific. Finally, the reporting of toxicology-related issues by the print and electronic media frequently presents an inaccurate or incomplete picture of the scientific aspects of these issues.

To the lay public and even some members of the scientific community, risk assessment appears to be an activity which is objective and precise. On the contrary, as currently practiced by some organizations, risk assessment is often based on a subjective evaluation of scientific data and the quantitative estimations of chemical risks, particularly those for cancer, frequently have little or no scientific basis.

The scientific debates on the risks posed by various chemical and physical factors in the environment often resemble a struggle for political position among individuals and groups with different interests rather than an objective examination of the scientific issues. In this debate toxicological data are often used in inappropriate ways to reinforce the different points of view. In a recent speech, Rep. George E. Brown (D-Calif, C&EN, May 31, 1993, page 9) stated that "Political expediency will always play a greater role in

policy-making than will analytical thinking, scientific or otherwise." He stated further that: "Successful politics, not good science, resolve conflicting values"; "politicians and scientists sometimes participate in a tacit, mutually aggrandizing conspiracy about prediction"; and "scientists would much prefer to have generous support for their research than to point out that understanding a phenomenon is not the same as predicting it."

There is also the impression among the general public and some members of the scientific community that the interpretation of toxicology data is difficult and controversial. This is not necessarily true. Toxicology research, when properly conducted using established scientific methods, provides information on which valid and noncontroversial conclusions can be reached. It is when attempts are made to reason beyond the data with the injection of policy considerations and default assumptions that controversies occur. Properly trained toxicologists are generally able to reach objective conclusions about the meaning of a body of scientific data. There may, on occasion, be some disagreement about the conclusions. However, it must be kept in mind that science is concerned with reaching conclusions supported by the preponderance of the data. There will always be some uncertainty about conclusions reached by trained, objective observers in the biological and physical sciences. But, in general, objective scientists arrive at conclusions about the meaning of a body of data with less uncertainty than other professional groups. It is important to keep in mind that the ability of toxicologists to reach the best judgment as to the meaning of a body of data with regard to human health risks is almost always compromised when nonobjective reasoning is used and political and financial factors influence the evaluation process.

In the interpretation of toxicology data relative to the risks to human health, the objective should be to make the reasoning compelling and logical. Within the toxicology community there are individuals and groups of individuals whose primary purpose is not to objectively report and advance the knowledge of the potential adverse effects of chemicals on living organisms but rather to manipulate the

interpretation of toxicological data to fit their own agendas. There is no better example of this than the current debate over the toxicity to humans of low-level exposure to the chlorinated dibenzo-p-dioxins and related compounds. These special interest groups project advocacy rather than scientific expertise thus politicizing the process of determination of physical and chemical risks to human health and the environment. The scientific interpretations of toxicology data by these special interest groups are often not based on reasoned judgments but are attempts to impose a different interpretation by virtually any means. The legitimate scientific community is partly at fault for this distorted state of affairs because they have let these interest groups set the terms of the debate. Representative Brown in the speech referred to previously, in addressing opposition to the irradiation of food as a means of preservation, noted that: "Perhaps worst of all, we have repeatedly witnessed seemingly qualified and objective medical and scientific professionals prostituting their credentials in calculated public attacks on food irradiation in attempts to serve their real political agendas." Although Rep. Brown's remarks were made relative to food irradiation, they apply equally to positions taken by some individuals and groups of individuals concerning other potential chemical and physical risks to human health.

These special interest groups or individuals are found in academia, in some federal, state, and local governmental research and regulatory agencies, and in certain industrial organizations. These special interest groups often depict themselves as champions of the truth. However, their pronouncements on issues of toxicology are often not creditable. In the current climate, the special interest groups with the cooperation of the media often appear to the public at large as the primary authorities on the risk to human health and the environment of physical factors and chemicals.

Some politicians, environmental groups, federal agencies, and academic scientists make careers and derive financial gain from expressing biased points of view concerning the toxicity of physical and chemical factors in the environment. If they adopted more scientifically accurate positions, they would run the risk of losing their financial support. Financial gain is probably the most important contributing factor to the public positions of these individuals or groups on toxicological issues. Furthermore, these special interest groups or individuals are generally not forthcoming on the role finances play in their activities.

Government agencies and academic scientists are not immune to financial considerations in arriving at conclusions concerning chemical and physical risks to human health and the environment. Financial support of these organizations and individuals often depends on an exaggerated perception of these risks by politicians, the courts, organizations awarding research funds, and the public at large. Consequently, their public positions concerning the risks

from chemicals are often hyped. Another factor contributing to the distortion of the magnitude of the toxic hazards is a lack of scientific competence among some special interest groups and individuals.

Thus, with some individuals and certain special interest groups objectivity is not the principal guide for their generation and interpretation of toxicological data. They view toxicology not as a means of arriving at the truth but, rather, as a means to support and defend their special view of the risk of chemical and physical factors to humans and the environment.

Strong differences of scientific opinion concerning the health risks of chemicals and physical factors in the environment attracts the attention of the media. In general, the media tend to report only those opinions that suggest increased risks. This is because the reporting must be entertaining or shocking in order to attract readers and viewers.

In the media coverage of instances of potential risk to humans from exposure to environmental chemicals and physical factors such as radiation, there are incentives against scientifically accurate reporting. If a completely balanced view of the issue were presented by the print media, the story would likely appear pedantic in character, would be assigned to the back pages, and would not likely interest the electronic media. Therefore, a completely accurate view of the scientific aspects of the matter is not presented and the personal aspects of the exposure are usually emphasized leaving the readers or listeners with an unbalanced view of the problem. In their reporting on chemical and physical risks to human health or the environment, reporters often represent themselves as advocates for the general public.

There are a select group of "toxicologists" to whom the media often turn for opinions on the toxic effects of chemicals and physical factors. These scientists rarely present an objective or balanced view of the issue at hand. The motivation of these individuals in presenting the distorted point of view is sometimes political but more often financial.

It is doubtful that an increased effort on the part of the toxicology community to encourage more scientifically accurate reporting of toxicology issues by the media would have an appreciable effect. The primary motivation of the media is to report on issues that increase readers or maintain ratings. Scientifically accurate reporting on these matters would not likely accomplish these goals. Unfortunately, the perception of the discipline of toxicology held by the public and some professional organizations are largely formed by what they hear on television or read in their newspapers.

The other major source of information on toxicology issues are the professional journals. There is an impression in the scientific community at large that publications in the journals devoted to toxicology are, in general, of mediocre quality. In part, this is because some of the journals publishing toxicology information do not utilize peer review in the

same sense or to the same degree as scientific publications in other scientific disciplines. These journals often serve as a means for expressing opinions about the meaning of scientific data which are speculative and which would not stand up under strict peer review.

It is hard to escape the conclusion that there are currently far too many toxicology journals chasing too few good quality papers. It appears that a number of the current toxicology journals could be deleted without materially affecting the efficient dissemination of significant research findings. In general, the journals sponsored by academically oriented toxicology societies appear to be more objective and of better quality than those organized and directed by publishing companies and governmental organizations. The quality of publications in toxicology journals would be greatly improved by the elimination of a number of these journals and the adoption of more rigorous editorial policies in the remainder with regard to the suitability of the manuscripts accepted for publication.

Risk assessment, as carried out by federal, state, and local regulatory agencies, is a necessary activity in controlling the exposure of humans to potentially toxic chemicals and hazardous physical factors. However, as currently practiced it lacks scientific rigor and reflects negatively on the discipline of toxicology. Stronger measures should be taken by toxicol-

ogy-oriented scientific societies to disavow assessments of human risk which do not adhere to scientific principles regarding the interpretation of experimental data. There should also be a greater effort on the part of regulatory agencies and other organizations reporting risk assessment information to describe what aspects of a risk assessment are supported by properly interpreted scientific data and which portions of the assessment are based on speculation and policy considerations.

Unlike any other scientific discipline, toxicology has attracted individuals and organizations whose reporting of information is modified by agendas which do not necessarily represent a search for truth. There should be a greater effort on the part of individual toxicologists and organized toxicology societies to refute information presented by special interest individuals and groups which is not supported by data generated in properly designed studies and which has been objectively interpreted.

Finally, is it desirable for toxicology to be viewed as a scientifically rigorous discipline? The answer is clearly yes. One of the most important reasons is that if we expect to recruit the bright students to the discipline of toxicology we must strive to be scientifically rigorous and objective. The good students are attracted to those academic disciplines which have those qualities.