Toward a National Systems Resource in Toxicology*

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The objective of the Toxicology Information Program is to become the recognized, accepted, authoritative, responsive, national center for access to information in toxicology and for information important to toxicologists and other health professionals. To achieve this goal, we plan to establish a computer-based facility to serve as a focal point for a network of information centers assuring greater accessibility to, and promoting greater utilization of, toxicology information. We thus hope to expedite the interchange of information, eliminate unnecessary duplication, foster exchange of ideas, and encourage the transfer of pertinent concepts from areas peripheral to toxicology.

During the 1950's, a multitude of problems in current information processing and dissemination became pressing enough to command the attention of the President's Science Advisory Committee (PSAC). As a result, the committee chairman, who is also the Special Assistant to the President for Science and Technology, in 1958 appointed a subpanel under the direction of William O. Baker to examine the status of information handling in the United States and to make appropriate recommendations. In 1962, the chairman asked James H. Crawford, Jr., to head a task force to investigate the federal handling of information, and in 1963, the President's Science Advisory Committee established a panel under Alvin M. Weinberg to explore the national status of information activities and to recommend immediate action. One of the recommendations of the Weinberg report, still ignored by most, was an admonition to practicing scientists to be more active in the management of scientific information, to involve themselves more directly. Emphasis was placed also on development of specialized information services, integrated and coordinated to form systems of national networks.

The President's Science Advisory Committee also gives particular attention to communication of information about factors which more directly affect the health of the nation. Thus, the publicized consequences of our growing exposure to an increasing number of toxicologic hazards focused attention of PSAC on deficiencies in toxicologic information transmittal. The committee became aware that, despite the existence of a wealth of information on the toxic effects of chemicals, a large part of this information remains inaccessible to many who need it. The information is widely dispersed through thousands of journals in preclinical and clinical sciences and chemistry, and much is neither abstracted nor indexed. Health authorities often fail to obtain information in emergencies, despite the existence of information concerning public health hazards attributable to the many chemicals in our environment.

Alarmed by the ever-growing toxicologic hazards, the President's Special Assistant for Science and Technology appointed a panel under Philip Handler to investigate the entire problem of information handling in toxicology. This investigation led to six findings and recommendations embodied in a report issued by the White House in 1966 entitled "Handling of Toxicological Information." On accepting this report, the President asked the Department of Health, Education, and Welfare (HEW) to develop a computer-based toxicologic information system and endorsed the joint efforts of the American Medical Association, the Food and Drug Administration, and the Pharmaceutical Manufacturers Association to coordinate their reporting of adverse drug reactions.

The panel foresaw extension of this coordination into a world-wide deleterious drug reporting system, and commended the furtherance of such efforts by the World Health Organization and the Food and Drug Administration. The Handler panel recommended the initiation of conferences with the information managers of relevant industrial organizations, with toxicologists in the professional societies and in various organizations concerned with toxicology information, and with appropriate officials of federal agencies.

Acting upon the President's directive, HEW requested the Public Health Service to establish and assume responsibility for the operation of a Toxicology Information Program. The National Library of Medicine was designated the responsible agent. Integration of this program's functions with HEW's many projects developing and using toxicologic information is the task of Dr. Philip Lee, Assistant Secretary for Health and Scientific Affairs and chairman of a Departmental Coordinating Committee responsible for determining overall program policy. Within the National Library of Medicine, the Associate Director for Specialized Information Services directs planning of the operating program.

More effective marshalling and use of information in toxicology, as recommended in "Handling of Toxicological

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Information," require effective program liaison with numerous organizations and programs within and outside the federal government. Within the government, liaison must be maintained with the National Institutes of Health, other agencies of the Public Health Service, the Food and Drug Administration, the Department of Agriculture and its National Agricultural Library, the Department of Interior, the Department of Commerce, the Department of Defense, and others (not the least of which is the Office of Science and Technology in the executive office of the President). Outside the government, liaison must be maintained with pharmaceutical, food-processing, cosmetic, and industrial chemical industries, as well as with trade and professional associations, such as the Pharmaceutical Manufacturers Association, the American Medical Association, the American Public Health Association, the American Industrial Hygiene Association, the Federation of American Societies for Experimental Biology, and with the National Academy of Sciences–National Research Council. Indeed, the NAS Division of Medical Sciences already have contributed valuable advisory services to the biomedical community, and we continue to turn to them for assistance.

Because toxicology is broader than national boundaries—the thalidomide tragedy is a case in point—liaison with international organizations such as WHO, FAO, and professional societies is of critical importance. The program's ultimate goals extend beyond incorporating unevaluated information and data into the system. A Conference of Users of Information in June 1966 specifically recommended more support for publication of critical reviews and for evaluative summaries of papers appearing in scientific journals. As soon as possible, we plan to implement this recommendation.

To become an authoritative, responsive, national referral point for toxicologic information, the Toxicology Information Program hopes to encourage development of a network of information centers in toxicology, for wider accessibility to, and utilization of, information in this and related subjects. The organizations on today's program are certain to be among the initiators and leaders in establishing information centers specializing in toxicologic information. Whether it be the Advisory Center on Toxicology, or the Pesticide Information Center, or the National Poison Control Centers and the Division of Occupational Health of the Public Health Service, or the American Medical Association, or the Food and Drug Administration, or the Chemical Abstracts Service, or the Army Chemical Information and Data System—all of us have a common interest in toxicology: safeguarding the public health by creating a specialized "network of knowledge" to provide quick and effective access to needed information.

Protection of the people's health demands more than reaction to a crisis. It involves not only development and use of environmental toxicologic data, but attention as well to the chemical burdens imposed on our environment.

In accord with its charter to view toxicology broadly, the Toxicology Information Program aims to build a referral activity to which relevant information will be brought spontaneously and freely from both the public and private sectors, and from which information will be disseminated to those who need it. The program design calls for a user-oriented facility embodying a responsible consensus of the community of toxicologists.

Toxicology, by definition, involves agents and hosts, actions and reactions. Any toxicology information program must include provisions for management of chemical components; such provisions, therefore, constitute a significant segment of our program. We have, however, no intention of displacing the formal professional information services now serving chemists.

One of our major goals is to encourage Chemical Abstracts Services to improve, supplement, and build on its system in order to provide toxicologists and related professionals with the kind of integrated information resources commensurate with their interests and needs. Through a contract of the National Science Foundation, the Food and Drug Administration, and the National Library of Medicine with Chemical Abstracts Service, the Library has received the registry numbers, nomenclature, and molecular formulas for the chemical compounds included in forty standard reference works of biologically significant substances. We will link to this file of 31,000 substances additional information, including biological effects.

To a considerable extent, NLM facilities can already provide references or bibliographies on toxicity; however, with the new chemical file developed under contract with the Chemical Abstracts Service, NLM will be able to improve and refine its indexing of bibliographic references for chemical agents.

Among our active pursuits is development of a Wiswesser Line Notation file for compounds manifesting important biological activities or for compounds in foods and other consumer items. With the aid of the Dow Chemical Co., the Library has already obtained line notations for some 10,000 compounds among those registered by Chemical Abstracts Service, notations to be shared with the FDA and made available to CAS. Although the notations themselves may never appear in the printed products of the program, we look upon this file as a convenience for classifying toxicologic literature in chemically meaningful terms.

With its computerized information services, the National Library of Medicine is particularly well-suited to develop the necessary specialized files and to render specialized services to the toxicologic community at large.

Upon recommendation from federal government and nongovernment consultants, the Library now publishes a computer-based quarterly, *Toxicity Bibliography*. In it are all references from NLM's computer-based Medical Literature Analysis and Retrieval System (MEDLARS) to which the sub-headings "toxicity," "adverse reaction," "poisoning," or "chemically-induced" have been applied.

Through a contract with Science Communication Inc., of Washington, D.C., we expect to determine the information-seeking behavior and motivations of those who require information in toxicology. The cooperation of respondents to our requests, or those of our contractors, and their care in responding to these requests will, of course, greatly expedite our success in meeting the needs of toxicologists.

Furthermore, the Toxicology Information Program, through a contract with Systems Development Corpora-

tion, is compiling a roster of nearly 2000 persons who can serve as expert advisors on toxicology or related subjects. (Since the Society of Toxicology numbers only 385 members, our file obviously will include advisors whose interests are tangential, as well as those whose interests are central, to toxicology.)

With assistance from industry, universities, professional societies and government, we hope gradually to develop an inventory of information resources indexed in depth to provide referrals to references, documents, evaluated data, and information. Additionally, the National Referral Center for Science and Technology of the Library of Congress, under an agreement with NLM, will publish a directory of general toxicology information services before the end of 1969.

The Library plans ultimately to maintain a file with the capability of supplying up-to-date information for access by data line telephone connection. Qualified users may then readily obtain information on a host of products and compounds with known or potentially toxic effects. The realization of this plan depends on our ability to create and maintain a file satisfactorily describing the capabilities and services of specialized information sources. Its realization depends also on the utilization of codes, standards, and criteria acceptable to participants in the toxicology information network. The dream of a truly responsive data and information resource would otherwise be impossible of realization.

A rational system of information handling requires common acceptance of forms, terms, and units of measure. Unless those who use services and those who provide them can understand each other, the system will be grossly ineffectual.

As planners responsible for national toxicologic information activities, we are sensitive to the influence which the structure and contents of our files and the nature of our computer programs will have upon establishment of standards of terminology, codes, practice, and information transfer. Any sizable, potentially useful resource must, by its very nature, influence the ways and means by which prospective users and contributors will interact with these activities.

Literature and the Creative Process—Help or Hindrance?*

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Introduction

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We begin with a user's view of our topic. I asked our user not to be objective; I think we have enough of objectivity. It is healthy occasionally to have some good, old-fashioned, strongly-held personal opinions about things, and a user certainly has a right to a good, old-fashioned, strongly-held personal opinion about whether information service available to him is any good.

I asked our user not to conduct a study among his colleagues and to report percentages about things, but to give us his personal views, as biased as he wishes to make them.

Our user who starts this panel is Dr. Erwin Klingsberg, a synthetic organic chemist and Research Fellow, American Cyanamid. Following him are: a chemist-librarian, Mrs. Mary Jane Bloemeke, University of Pittsburgh; an information processor, Dr. Eugene Garfield, President of ISI; and a computer system designer, Dr. R. L. Wigington, R & D director of Chemical Abstracts Service. No panelist represents his employer; each speaks as an individual member of a profession.

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Printed and Other Impediments to Creation

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As I organized my thoughts on creativity, I realized that they seemed to be centering on impediments to creation—hence, the title of the talk, and also perhaps the first lesson in creativity: If a problem seems baffling, turn it upside down. What are some of these impediments?

The first impediment I would like to mention is the librarian. Why do I say that the librarian is an impediment to be eliminated? Because the chemist, within his own field, must know the library better than she does, so that he is not dependent on her help. The chemist must have the sources in his field at his fingertips, including, for example, the indexing and organizational characteristics of the major sources like *Chemical Abstracts*, Beilstein, or encyclopedias, such as the Elsevier Encyclopedia. Depending upon the particular problem at hand, one or another of these sources may come up with the answer very much quicker, and we must know more or less automatically how to go about making the search in the most expeditious way.

After the chemist has mastered the sources completely and can find answers to his questions in minimum time, the next stage is somewhat harder to define. It represents what we might call the creative use of the literature.