Toxic Agent and Radiation Control: Meeting the 1990 Objectives for the Nation

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Synopsis

Toxic agent and radiation control is 1 of the 15 health priority areas addressed through the Public Health Service's Objectives for the Nation. Several gains in moving toward the 1990 goals for toxic agent and radiation control have been recorded.

Research and technical assistance, combined with legislation to reduce the amount of lead in gasoline, have contributed to a decrease in the mean blood lead level of the general population. New testing procedures have been developed to evaluate both reproductive and developmental toxicities of chemicals. Educational implementation of pelvimetry referral criteria in a multiyear study involving approximately 200 U.S. hospitals has resulted in a 50 percent reduction in the number of pelvimetries performed.

Health-related responses have been given to environmental problems such as exposures to polychlorinated biphenyls (PCBs) in Massachusetts and Florida and exposures to dioxin in Missouri and New Jersey. Chemical records for some 1,000 compounds likely to occur in chemical dumps or in bulk transit are being either created or updated to enhance online data retrieval services. For the foreseeable future, however, improvement of knowledge of the potential health risk posed by toxic chemicals and radiation must remain one of the most important priorities. To control toxic agents, development of surveillance systems and data bases are equally important.

MANY AMERICANS ARE EXPOSED to some kind of toxic agent or radiation health hazard. It is estimated that, of the 5 million chemical compounds that have been synthesized or isolated from natural materials, more than 55,000 are produced commercially. Approximately 350 new compounds are introduced into commerce annually; pesticide formulations alone contain more than 1,000 active chemical ingredients.

Diagnostic X-rays are used extensively in medicine and dentistry. Ionizing radiation causes both genetic and somatic damage in humans—carcinogenesis is the principal concern. Exposure to toxic agents can produce chronic lung disease, cancer, degenerative disease in a number of vital organ systems, birth defects, and genetic damage. These health effects are a major health problem in this country, cause patients enormous suffering, and cost billions of dollars annually for health care and loss of productivity.

In light of these serious health problems, control of toxic agents and radiation has been identified as 1 of the 15 prevention priority areas to be addressed by the Public Health Service (PHS) through its 1990 Objectives for the Nation initiative (*1,2*). Ten of the objectives related to toxic agent and radiation control are priorities for the Federal effort (see box).

Recent experience has demonstrated that many environmental health hazards can be prevented or controlled by identifying the toxic substances and then modifying the environment or individual activities, or both. Because diagnostic X-irradiation is an intentional source of human exposure, it accounts for more than 90 percent of the total man-controlled (and therefore potentially controllable) ionizing radiation burden of the U.S. population.

But for toxic agents the most difficult problem remains. Although most existing chemicals probably are not hazardous to humans, relatively few of the thousands of commercially important chemicals have been subjected to extensive toxicity testing and most have scarcely been tested at all. Identifying which substances are toxic and determining the severity of the risk so that exposure to the most toxic substances can be controlled is an enormous task that will take decades. But, as more is learned about environmental health hazards, decisions can be made from this base of knowledge either to limit use of dangerous substances or to tolerate a minimal risk

1990 Priority Objectives for Toxic Agent and Radiation Control

Improved health status

1. By 1990, 80 percent of communities should experience a prevalence rate of lead toxicity of less than 500 per 100,000 among children 6 months to 5 years; at least 90 percent of all children identified with lead toxicity in the age group of 1–5, especially those ages 1–3, should have been brought under medical and environmental management.
2. By 1990, significant progress should have been made toward preventing birth defects or miscarriages resulting from exposure to toxic substances through environmental interventions based on current information and expansion of the knowledge base related to hazardous substances and their reproductive effects.

Reduced risk factors

3. By 1990, the number of medically unnecessary diagnostic X-ray examinations should be reduced by some 50 million examinations annually.

Increased public-professional awareness

4. By 1990, at least half of all adults should be able to report accurately an accessible source of information on toxic substances to which they may be exposed, including information on interactions with other factors such as smoking and medications.
5. By 1990, at least half of all people ages 15 years and over should be able to identify the major categories of environmental threats to health and note some of the health consequences of those threats.
6. By 1990, at least 70 percent of all primary care physicians should be alert when taking histories and making diagnoses to the role that environmental and occupational exposures can play in increasing the incidence of disease and health disorders, and be alert to how these exposures should be prevented or limited.

Improved services-protection

7. By 1990, every individual residing in an area of a population density greater than 20 per square mile, or in an area of particularly high risk, should be protected by an early warning system designed to detect the most serious environmental hazards posing imminent threats to health.
8. By 1990, every populated area of the country should be able to be reached within 6 hours by an emergency response team in the event of exposure to an environmental hazard posing acute threats to health from a toxic agent, chemical, and/or radiation.

Improved surveillance-evaluation systems

9. By 1990, a broad scale surveillance and monitoring system should have been planned to discern and measure known environmental hazards of a continuing nature as well as those resulting from isolated incidents. Such activities should be carried out continuously at both Federal and State levels.
10. By 1990, a central clearinghouse for observations of agent-disease relationships and host susceptibility should be fully operational, as well as a national environmental data registry to collect and catalog information on concentrations of hazardous agents in air, food, and water.

SOURCE: Reference 2.

because of overriding benefits to society. Nitrite-cured meats are a case in point: the nitrite may promote cancer, yet it protects against botulism.

Definitive answers cannot be given about the extent of risk to public health from exposure to radiation and, particularly, toxic chemicals. The PHS, however, is carrying out many programs and studies that one day may reduce the uncertainties associated with assessing these public health hazards and, more important, lead to a reduction in disease incidence and severity. With the expanded knowledge base and information that result from these activities, it should be possible to develop other specific and effective prevention measures to reduce the likelihood of toxic effects from environmental factors. In the foreseeable future, however, improvement of our knowledge of the potential health risk posed by toxic chemicals and radiation must remain one of the most important priorities. For toxic agents, development of surveillance systems and data bases are equally important. Even though much remains to be done, significant progress already has been made in toxic agent and radiation control.

Improved Health Status

Lead toxicity. According to the second National Health and Nutrition Examination Survey (NHANES II), conducted between 1976 and 1980, 4 percent of U.S. children ages 6 months to 5 years had blood lead levels that exceeded the Centers for Disease Control (CDC) guidelines for blood lead levels (*3*). Reduction of this problem in children is vital because research indicates that even relatively low levels of lead exposure in young children may be associated with psychoneurological deficits and behavioral disorders.

Although the States have primary responsibility for lead-related prevention activities under block grant legislation, the PHS, primarily through the Health Resources

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and Services Administration (HRSA) and the Centers for Disease Control, also is actively addressing the problem of undue lead absorption. The PHS is reassessing existing policies and procedures for lead poisoning prevention; identifying new needs for training, research, and services; and providing leadership to States and communities by encouraging the initiation and expansion of lead poisoning prevention activities. Specifically, the PHS has:

- provided program guidance to State and local health agencies for conducting routine, periodic erythrocyte protoporphyrin screening of all preschool children, not only those at high risk.
- supported a 2-year research project to demonstrate the clinical applicability of X-ray fluorescence as a safe, sensitive, and noninvasive method of measuring bone lead in children.
- supported a study to examine the effects of calcium EDTA and d-penicillamine in mobilizing essential elements in children undergoing chelation therapy for lead, with the goal of decreasing the danger of such therapy.
- conducted one erythrocyte protoporphyrin in collaboration with the State of Wisconsin and two lead proficiency testing programs.
- supported training projects for, and provided guidance to, States on aspects of identification and abatement of lead hazards and of elimination of lead exposure.
- supported a contract with the New Jersey Children's Television Workshop to design and develop education programs, in both English and Spanish, for parents and the general public on childhood lead poisoning (*4*).

The PHS also assists State programs for the prevention and treatment of childhood lead poisoning. New York and New Jersey have such programs funded by block grants. A standardized recordkeeping system and a lead poisoning prevention program protocol are being developed in New York to ensure appropriate medical and management followup of children. In New Jersey, an experimental project is underway to develop linkages with local school districts to screen preschool and primary grade children for lead poisoning if they have learning problems.

The combination of these activities with legislation to reduce the amount of lead in gasoline has contributed to a decrease in the mean blood lead level of the general population. However, lead-based paint still is present in a large percentage of homes constructed prior to 1960. The lead-based paint in those homes may expose children to lead and must continue to be addressed in order to meet the objective for lead toxicity.

Birth defects. Through the National Toxicology Program (NTP) and CDC, the PHS makes extensive efforts to prevent birth defects and miscarriages resulting from exposure to toxic substances. The NTP's Reproductive and Developmental Toxicology Program is developing a wide range of techniques to evaluate potential toxic effects of chemical exposure on the reproductive system and developing embryo, and it is improving testing procedures for uncovering such effects (*5*). Resources from three PHS organizations are pooled for use in this program: the National Center for Toxicologic Research of the Food and Drug Administration (FDA); the National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health (NIH); and the National Institute for Occupational Safety and Health (NIOSH), CDC.

A major effort of the NTP has been the testing of chemicals for teratogenicity, embryotoxicity, and reproductive effects using currently available procedures as guidelines. In addition, NTP has begun using several new testing procedures, with the goal of screening larger numbers of chemicals. With these efforts underway, research is beginning to focus more on defining endpoints, developing information on cellular effects and alterations in underlying processes, and understanding how the effects and alterations are related to the outcome of reproductive or developmental toxicity.

In one example of the NTP's new testing procedure, male and female reproductive indices are added to the subacute (90-day) toxicity study. This protocol makes use of animals that already are being studied and simply adds a few indices of fertility and reproductive function that can be used to establish priority for further testing. Another testing protocol NTP researchers have developed, fertility assessment by continuous breeding, is being compared with the currently used multigeneration study as a possible way of cutting time and costs by as

much as two-thirds. This NTP protocol has more indices of fertility and reproduction than the multigeneration study.

Overall, the agency's program is one of the most thorough approaches available for evaluating both reproductive and developmental toxicity. It should help identify chemicals capable of causing birth defects and miscarriages, permitting additional preventive measures to be developed and implemented.

A major CDC program on birth defects uses a number of surveillance systems. Data from these systems and other sources allow epidemiologic studies and applied research to elucidate the relationships between exposure to environmental agents and the occurrence, scope, and other aspects of adverse health outcomes. For example, the CDC has:

- established the Reproductive Outcomes Monitoring Project to monitor births and fetal deaths for parental, industrial, or occupational associations.
- registered a total of approximately 16,000 cases from 387,000 births since the Metropolitan Atlanta Congenital Defects Program was begun in 1967. Among findings from the program was the demonstration of no association between spermicide usage and reduction deformities (shortened or missing limb bones) or Down's syndrome.
- monitored 12 million births nationally for 200 birth defect categories since the Birth Defects Monitoring Program (BDMP) was initiated in 1974. Analysis has begun of BDMP records to identify areas of the United States that may have environmentally related causes of birth defects. Selected target areas will be identified for further followup.
- coordinated review of data from the International Clearinghouse for Birth Defects Monitoring Systems, which suggested that valproic acid may cause spina bifida. PHS researchers found that pregnant women exposed in the first trimester have a 1–2 percent chance of bearing a child with spina bifida, a 10- to 20-fold excess over background rates. This finding resulted in a letter from the manufacturer to more than 200,000 physicians, calling attention to this newly identified human teratogen and the estimate of risk (*6,7*).

Reduced Risk Factors

Unnecessary medical radiation exposure can be controlled both by the elimination of unnecessary X-ray examinations (without value to patient care) and by the reduction of the total radiation dose in necessary examinations.

Unnecessary X-ray examinations. To reduce the number of unnecessary X-ray procedures, the FDA has begun a program to develop and disseminate diagnostic radiology referral criteria in conjunction with the medical professions. Referral criteria are guidelines for efficacious use of certain diagnostic procedures under certain conditions of patients' histories, signs, and symptoms. These criteria are developed with government assistance by panels of practicing physicians and subsequently reviewed and ratified by professional medical societies.

When approved referral criteria have been disseminated under appropriate educational protocols, FDA researchers found that physicians use them in making decisions on use of diagnostic procedures (*8,9*). This use leads to a reduction of unnecessary and unproductive use of the procedures, which, in turn, reduces patient radiation exposure and diagnostic radiological costs. For example, in a multiyear study of the use of X-ray pelvimetry in approximately 200 U.S. hospitals, the presentation of the pelvimetry referral criteria in a 1-hour educational seminar was shown to result in a 50 percent reduction in the number of pelvimetries performed in study hospitals as compared with control hospitals (*6*).

Excessive X-ray dose. To reduce the radiation exposure required to produce high-quality diagnostic X-ray images for necessary radiological procedures, FDA uses a multifaceted approach. FDA's program uses technological advances in diagnostic imaging (such as a higher speed intensifying screen and higher speed film) and techniques (such as shielding and quality control of image processing) to avoid unproductive radiation exposure. The FDA has investigated and promoted the use of refinements of conventional X-ray procedures, equipment, and techniques that greatly enhance the amount of diagnostic information obtained per unit of ionizing radiation dose received by the patient.

This performance enhancement can be exploited by obtaining more diagnostic information without increasing the radiation dose or by maintaining the information level while reducing the dose substantially. For example, in the last 10 years it is estimated that doses to the female breast in mammography have been decreased to roughly 10 percent of former levels while diagnostic performance has actually increased (*10*). Further reductions by a factor of three are anticipated with continued improvement. Reduction of breast X-ray doses is exceedingly important because the breast is one of the most radiosensitive organs of the human body.

In addition to evaluating new breast imaging technologies, FDA has successfully implemented a nationwide program in conjunction with the American College of Radiology and the State radiation control agencies to evaluate the performance of nearly all the nation's mammography facilities. This program has resulted in an

average mammography exposure reduction of about 25 percent and significant improvement in the diagnostic quality of mammography imaging performed in this country. Similar programs for other X-ray examinations are being developed.

Increased Public and Professional Awareness

The health implications of exposure to toxic agents and radiation are not precisely known, but sufficient information is available and continues to accumulate to confirm that a wide range of acute and chronic health problems results from exposure. To increase public and professional awareness of sources of information on environmental health hazards and of the major categories of environmental threats to health, as well as to alert physicians to the necessity of obtaining information on environmental and occupational exposures when taking histories and making diagnoses, the PHS is taking many educational and information measures.

These measures include (*a*) preparation and dissemination of scientific papers, booklets, and manuals directed to both the general population and the environmental public health community, (*b*) presentations to the public and at scientific meetings on specific environmental problems and general environmental health issues, (*c*) creation and updating of various data and information systems, and (*d*) support for studies of role delineation for radiological technologists that includes the knowledge and skills for minimizing radiation doses. For example, the PHS has:

- conducted training programs on occupational factors in disease at educational resource centers throughout the country.
- made available 30–40 courses each year on occupational health to personnel in Federal and State agencies and in the private sector.
- given consultations regarding the laboratory aspects of environmental health hazards to various agencies and physicians.
- developed a 20-minute module curriculum, dealing with environmental and occupational health, for medical students and primary care residents.

Through CDC, the PHS also provides technical assistance and engages in cooperative activities through telephone calls, letters, onsite visits, direct services, training, cooperative agreements, and other measures. One example of assistance aimed at increasing public and professional awareness is a pilot project operated by CDC in 1983 to provide information to poison control centers for treatment of chemical exposures.

Improved Surveillance-Monitoring Systems

Surveillance and monitoring. The CDC plans, directs, and coordinates a national program to prevent or control environmentally related health programs. As the PHS lead agency, the CDC develops, stimulates, and implements operational programs for environmental health problems, including response to environmental, chemical, and radiation emergencies. This national program includes implementation, through an interagency agreement, of many responsibilities of the PHS Agency for Toxic Substances and Disease Registry, which is responsible for PHS Superfund activities.

In surveillance and monitoring, CDC has:

- developed and maintained surveillance systems. Such systems are developed and operated in cooperation with the National Center for Health Statistics (NCHS), NIEHS, the States, and other organizations.
- served as lead PHS agency for responding to environmental, chemical, and radiation emergencies and for conducting health hazard evaluations.
- provided a wide range of health-related support for responses to environmental problems such as (*a*) PCB exposure in Massachusetts, Florida, Michigan, Georgia, Arkansas, and Delaware, (*b*) pentachlorophenol exposure in New York, Wisconsin, Florida, Georgia, West Virginia, New Hampshire, Tennessee, and Kentucky, and (*c*) dioxin exposure in Missouri and New Jersey.
- conducted applied research in technology development for determining toxic exposures and possible health effects.
- evaluated, improved, or developed analytic methods, various tests, and materials.
- transferred information concerning appropriate use of existing, improved, and new technology through scientific papers, training, and consultation.

Central clearinghouse. The National Library of Medicine (NLM), NIH, is responsible for establishing and maintaining an inventory of literature, research, and studies on the health effects of toxic substances; for carrying out PHS activities under Superfund legislation; and for working toward the 1990 prevention objectives. The library is targeting its efforts toward (*a*) augmentation of NLM chemical and toxicological data bases and (*b*) improvement of computer capabilities to build data bases and to access and retrieve information from them.

The greatest emphasis is being placed on enhancing NLM's Toxicology Data Bank (TDB), an online data retrieval service in toxicology with some 4,000 records of chemicals with substantial human exposure or evidence of being hazardous. The data base describes the

chemical's human and animal toxicity, chemical and physical properties, environmental information, and manufacturing and use information. Data base content is reviewed by the TDB Peer Review Committee, a group of experts from the NIH Toxicology Study Section.

The present TDB file is being enhanced in two directions:

1. Chemical records are being created or updated for some 1,000 compounds likely to occur in chemical dumps or in bulk transit.
2. The records are being expanded with data and information in areas new to the TDB, such as environmental effects, safety and handling, and exposure.

Currently, TDB data are taken primarily from monographs and the primary journal literature. Advice on data record structure and compound selection is being obtained from two interagency groups of the Department of Health and Human Services. These interagency groups are the Hazardous Waste Information Evaluation Subcommittee of the Committee to Coordinate Environmental and Related Programs and the Information Workgroup of the Superfund Implementation Group.

Work is continuing on improving the computer systems used for data base building, peer review, and online information delivery. Total implementation of all phases of this integrated system is on schedule for November 1984. Concurrent with this development has been the effort by NLM, in collaboration with certain groups in CDC and the Environmental Protection Agency (EPA), toward the implementation of a microcomputer-based work station. This work station, which is now in the prototype stage, will be used in a network with other microcomputers or online terminals to provide rapid access to information on toxic substances.

New manuals, pocket guides, and audiovisual training packages, and more exhibits at professional meetings on toxicology and industrial hygiene have been prepared in a systematic effort to increase the users' awareness of, access to, and use of NLM services.

Achievement of the 1990 Objectives

Achievement of the toxic agent and radiation control objectives will require continued development of activities that supplement and complement those of the Federal Government. State and local health departments already support pollution control and lead poisoning screening and treatment programs. Similarly, professional medical organizations are being encouraged to offer continuing education courses to primary care physicians on the health consequences of the major categories of environmental contaminants.

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Activities are being focused on high-risk populations (such as women of childbearing age who are exposed to toxic agents at their worksites) to examine the possible association between exposure to toxic substances and potential problems and to alert them to actions they could take to reduce or eliminate the possibility of adverse health effects. These activities include surveillance programs of employees' reproductive outcomes and development of studies to examine possible associations between exposure to toxic substances at hazardous waste sites and low birth weights.

Such a pluralistic process involving public and private participants from many sectors and backgrounds is necessary if the toxic agent and radiation control objectives are to be achieved. The role of the Department of Health and Human Services in this process will continue to be to lead, catalyze, and provide strategic support. In this role, the Department will:

- expand the scope and role of biomedical research into mechanisms of action of toxic agents, alone or in combination.
- continue to educate users about unnecessary radiation in order to minimize their exposure to such radiation.
- strengthen its capacity to develop new methods to address specific questions of toxicology and epidemiology and to conduct toxicity tests.
- build capabilities for responding to acute short-term problems of environmental contamination.
- develop the ability to identify and respond to long-term environmental health problems and prevent adverse health consequences.

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Worksite Health Promotion in Colorado

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THE WORKSITE HAS BECOME the target of numerous groups seeking to improve the health of the adult population. In 1979, the Public Health Service's Office of Health Information and Health Promotion held the first national conference to focus attention on health promotion in occupational settings. "Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention" cites the workplace as an "appropriate setting for health promotion" (*1*). "Promoting Health/Preventing Disease: Objectives for the Nation" recommends specific worksite health promotion and health protection measures (*2*). Recently, the Department of Health and Human Services awarded a contract to Research Triangle Institute, Research Triangle Park, N.C., to provide for a definitive evaluation of the effectiveness of worksite health promotion programs.

Complementary private sector efforts have likewise intensified in recent years. Foundations have awarded grants for the development of pilot programs in occupational settings. A number of business coalitions, such as the Washington Business Group on Health, have formed to promote the dual objectives of cost-containment and improved employee health. The insurance industry, with the advice of medical experts, has produced motivational and technical materials to urge and help businesses to develop worksite health promotion and disease prevention programs.

Activities in Colorado have followed a pattern similar to that at the national level. The State Health Department, supported by Federal funds, has offered technical assistance to businesses to encourage the development of worksite hypertension screening and general cardiovascular risk-reduction programs for employees. In 1978, the Gates Foundation sponsored a statewide conference for leaders of major Colorado institutions, to examine the role that lifestyle programs could play in containing health care costs and improving the health of employees, clients, and constituents. Beginning in 1980, foundation funds were used to establish a nonprofit corporation, the Institute for Health, to assist businesses in decisionmaking and program management related to health promotion and disease prevention activities for their employees. Local hospitals, health departments, and community agencies developed worksite health promotion service packages that were made available to area businesses.

The rationale for worksite programs, their benefits, and strategies for implementing them have been clear to