Health Hazards from New Environmental Pollutants

Report of a WHO Study Group

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World Health Organization, Geneva 1976

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WHO STUDY GROUP ON HEALTH HAZARDS FROM NEW ENVIRONMENTAL POLLUTANTS

Geneva, 30 September–5 October 1974

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HEALTH HAZARDS FROM NEW ENVIRONMENTAL POLLUTANTS

Report of a WHO Study Group

A WHO Study Group on Health Hazards from New Environmental Pollutants met in Geneva from 30 September to 4 October 1974. Dr A. S. Pavlov, Assistant Director-General, opened the meeting on behalf of the Director-General. He emphasized the importance of a preventive approach in environmental health. This approach involves forecasting both the potential environmental hazards to health that might result from technological developments, and the changes within a community, including changes in its demographic, socioeconomic, psychophysiological, and cultural characteristics, that might influence the patterns of exposure to pollutants and the resulting effects on health. It is also necessary to estimate the time required for the interaction of the environmental agents with the community to produce significant perturbations in the health of the population. This is particularly important for substances such as potential chemical carcinogens, for which there is a time lag between exposure and effect that may be of the order of twenty or more years. He said that the Study Group's tasks were to assess the existing methods of forecasting health hazards from new environmental pollutants, to review some priority problems, and to provide guidance on the initiation of national programmes in this field.

1. INTRODUCTION

Technological developments during the last century have brought about a rapid increase in the use of natural substances, such as minerals and oils, and developments in chemistry have made it possible to synthesize a large number of organic chemicals for industrial use. The range of materials used in industry is still increasing and because of deficiencies in the procedures for forecasting possible effects on man and his environment it has not been possible to prevent numerous acute and chronic diseases in both industrial workers and the general public. Even when attempts have been made to forecast health effects, the tests have been inadequate to prevent some health problems—the teratogenic effects of thalidomide being a case in point.

Governments, responsible agencies, and the general public, are becoming increasingly aware that new chemicals, changes in the use of old ones, and changes in methods of energy production should be carefully evaluated before they are introduced. However, with the exception of new drugs, pesticides, and food additives, most countries do not require new chemicals to be tested before they are made available for industrial processes or for sale to the public.

This report is mainly concerned with assessing the usefulness and limitations of methods of forecasting environmental health hazards arising from developments in chemical industries.

2. BACKGROUND

Although the World Health Organization has frequently stressed the need for a preventive approach in its health programmes, including that on environmental health, only a few programmes have been specifically preventive rather than corrective. Examples of such programmes are the annual meetings, since 1956, of the Joint FAO/WHO Expert Committee on Food Additives that have evaluated the toxicity of food additives of all kinds, and the joint FAO/WHO meetings on pesticide residues in food that have been held since 1961. The World Health Organization is at present undertaking an extensive programme for the evaluation of new insecticides for the control of vectors of disease, in collaboration with a number of WHO collaborating centres and field research units.[a] The International Agency for Research on Cancer is at present evaluating the carcinogenic risk of a range of chemicals to man.[b] The need for a systematic programme to identify new environmental health hazards was stressed in 1972 by a WHO meeting on environmental health criteria and standards [c] and the idea was pursued at the meeting of a WHO Scientific Group on Environmental Health Criteria in 1973.[d] The Twenty-sixth World Health Assembly in its resolution WHA26.58 requested the Director-General to accord high priority *inter alia* to the early identification of environmental health

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[a] WRIGHT, J. W. *Bull. World Health Organ.*, **44**: 11–22 (1971).

[b] INTERNATIONAL AGENCY FOR RESEARCH ON CANCER. Monographs on the evaluation of carcinogenic risk of chemicals to man, vol. 1–7, Lyon, 1972–74.

[c] The WHO environmental health criteria programme (unpublished WHO document EP/73.1).

[d] Environmental health criteria : report of a WHO Scientific Group (unpublished WHO document EP/73.2).

hazards and to the prevention of their effects.[a] The problem was also touched upon by a WHO Expert Committee on the planning and administration of national programmes for the control of adverse effects of pollutants.[b] As a result of these recommendations and within the terms of reference of the WHO environmental health criteria programme, preliminary reviews were prepared in 1974 for a number of potential pollutants, such as tellurium, selenium, molybdenum, germanium, titanium, and tin, and their compounds, and for selected petroleum products.

Simultaneously, the World Health Organization is also developing a programme on health and environmental monitoring and a meeting of experts was convened in July 1974 to establish the framework for this programme.

Some international activities, particularly within the United Nations Environment Programme, in ILO, UNESCO, FAO, WMO, and IAEA, are related to the subject of this Study Group, as are those of other intergovernmental or nongovernmental organizations, such as the Commission of the European Communities (CEC), the Organization for Economic Cooperation and Development (OECD), the Council for Mutual Economic Assistance (CMEA), and the International Council of Scientific Unions (ICSU). References to these activities may be found in the appropriate sections of this report.

3. FORECASTING IN ENVIRONMENTAL HEALTH

3.1 Technology forecasting

The goals of technology forecasting as applied to environmental health are the systematic identification, analysis, and evaluation of the potential effects of technological developments on human health. Additional objectives include the assessment of second and third order effects of technological developments, and estimation of the unplanned or unintended consequences, both beneficial and detrimental, of new technologies or of changes in the utilization of existing technologies. Such forecasting must also assess and identify means of preventing such environmental problems.

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[a] Handbook of resolutions and decisions of the World Health Assembly and the Executive Board, vol. II (1973–1974). Geneva, World Health Organization, 1975.

[b] WHO Technical Report Series, No. 554, 1974.

The main value of such activities is that they give scientists and administrators in government and industry an opportunity to take action before a health problem develops, rather than after the recognition of an environmental emergency. At present, technology forecasting is limited to estimating source strength, types of chemical, and anticipated exposure levels and the value of these estimates is, of course, governed by the validity of the data base and the methodology used to make them. Common sense and experience thus still play a large part in making the final forecast.

An important tool in technology forecasting is trend analysis, which shows how a particular technology is developing. This may be expressed as the percentage increase or decrease in the quantity of a chemical product produced per annum or as the annual percentage increase or decrease in the electrical power generating capacity of a particular generating authority. The factors that influence rate of growth are supply and demand of raw material, availability of the process technology, customer response, and government regulations. It is necessary to understand the existing stage of development of industry and agriculture and its history before it is possible to forecast future trends.

Health assessments should be included in each step of the production process, from raw material procurement to waste disposal, and progressive integration of industrial and health research would appear to be the best approach to technology forecasting in relation to environmental health.

By focusing on industrial processes, a good understanding can be gained of the sources of pollutants, methods of release, rates of release to the environment, and environmental transport and transformation.

The need for forecasting is indicated by the following examples:

(1) Inorganic mercury used in an acetaldehyde manufacturing plant at Minamata Bay, Japan, was converted to methylmercury in the environment. Fish and shellfish became polluted in Minamata Bay and local people who ate large quantities of fish were severely affected by mercury poisoning. A better knowledge of possible methylation reactions could have prevented this episode.

(2) Cases of poisoning occurred in Japan in 1968 when polychlorinated biphenyls leaked from heating equipment in contact with rice oil.[a] A full toxicological assessment should have been made before this material was introduced into the food industry.

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[a] KURATSUNE, M. ET AL. *Environmental health perspectives*, experimental issue, No. 1, pp. 119–128 (1972).

(3) Bischloroisopropyl ether has been identified in the Ohio and Rhine rivers, down-stream of plants producing propylene oxide. While there is no evidence that this chemical poses a hazard at present, it should be included among the existing and potential water pollutants that merit further investigation.

(4) Poly(vinyl chloride) resin has been prepared from vinyl chloride monomer for some 40 years and the current annual world production exceeds 12 million tonnes. Recently it was discovered in several countries that workers in this industry had developed angiosarcoma of the liver. A better understanding of the toxicology of this compound might have led to earlier measures to eliminate human exposure to vinyl chloride.

(5) Instances of fatal ingestion of hexachlorobenzene by livestock have been reported. Such poisoning could have been prevented if the toxicity of this chemical had been widely publicized.

Technology forecasting for environmental health, by identifying possible hazards, is of great potential value in eliminating or reducing the adverse effects but this will be achieved only if the knowledge gained is applied in good time.

3.2 Chemical structure and biological activity

Careful account should be taken of information on the relationship between physico-chemical properties, chemical structure, and biological activity to help in forecasting the hazards of chemical substances polluting the environment. So far, however, this approach has been of limited value.

In some cases it may be possible to evaluate the potential synergistic effects of a new chemical. For example, its structure may suggest that its degradation by enzymatic processes will compete with other related environmental pollutants for specific enzymes, as is the case with some organophosphorus pesticides, or the chemical may act as an enzyme inducer, as is the case with organochlorine pesticides and some other compounds, and in that way decrease or increase the toxicity of other pollutants. These possibilities are easier to predict than, for example, cases of toxicity affecting specific tissues, as in the case of carcinogenicity where the greatest effort has been made to predict activity, since this kind of activity is not closely related to structure.

The structural requirements for carcinogenicity of aromatic amines have been altered in the light of recent knowledge; now only one

aromatic ring is considered essential for carcinogenicity and not two rings as was thought previously. Important structure–carcinogenicity relationships have been demonstrated for bischloroalkyl ethers. Activity decreases rapidly with increasing distance between the chlorine and oxygen atoms in the molecule.

Carcinogenic activity has been discovered in many diepoxides but among the monoepoxides activity is weak or absent, so that accurate prediction is not possible. For lactones, ring strain is a requirement for activity and carcinogenicity is absent in compounds with larger, unstrained ring systems.

Among nitrosamines, the alkyl nitrosamine compounds lose carcinogenic activity with increase in length of both alkyl side chains and no activity is observed when both are aryl substituents. However, for some compounds the observed lack of activity could not have been predicted from structural considerations, for example, dinitrosopentamethylenetetramine and *N*,*N*′-dimethyl-*N*,*N*′-dinitrosoterephthalamide.

These examples from the voluminous literature on carcinogenesis show that a knowledge of the relation between the structure of chemicals and biological activity can be of value in assessing the need for bioassay of new compounds and in planning testing procedures. It will help to ensure the choice of an appropriate animal or strain, the proper attention to target organs, the proper mode of administration and time of observation, and the appropriate choice of positive controls for the study. Such an assessment must not, however, replace biological testing.

The relationship between chemical structure and activity has been of great importance in medical and pharmaceutical research, because compounds closely related in structure to physiologically active chemicals have been found to act as antimetabolites and good advantage has been taken of that fact.

3.3 Assessment of the behaviour of chemicals in the environment

The use of chemicals in everyday life has increased considerably and will continue to do so, and residues of these compounds are likely to increase in air, water, soil, the food chain, and living tissues. The persistence in the environment of DDT, polychlorinated biphenyls (PCB), and some mercury compounds, for example, has caused serious concern and indicates the need for thorough investigation of the total environmental impact of all chemicals.

The physicochemical properties of a compound are important in determining the chemical's behaviour in the environment. These proper-