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Working Group on Epidemiological Surveillance Systems

Gabrovo, Bulgaria, 17-20 October 1978

REPORT

1. Introduction

The Working Group, concerned with systems for epidemiological surveillance of the long-term effects of environmental hazards on human health, was convened by the WHO Regional Office for Europe in Gabrovo, Bulgaria, from 17 to 20 October 1978. A list of participants is given in Annex I.

The objectives of the Group were (i) to determine the requirements of a system for surveillance of health and environmental hazards and (ii) to recommend fields in which pilot schemes would be worthwhile. It was understood that such schemes would, in the main, have to be based on information already being collected concerning health or the environment - or both if it could be satisfactorily interrelated.

The participants were welcomed by Professor F. Kalojanova, Director of the Institute of Hygiene and Occupational Diseases, Sofia, and by Dr S. Serafimov of the Gabrovo Department of Public Health and Social Welfare. Dr D.K. Sokolov, who opened the meeting on behalf of Dr Leo A. Kaprio, WHO Regional Director for Europe, stated that although difficulties were faced in devising methods for surveillance of long-term effects of environmental hazards on health such surveillance was increasingly necessary as more and more potentially harmful substances were entering the environment, and it was therefore time to consider the design and operation of programmes and to suggest where pilot schemes might be introduced.

Dr B. Baikushev was nominated chairman and Dr R. Cederlöf vice-chairman. Dr C. du V. Florey, who had prepared a background paper for the Group, acted as rapporteur. Dr Z.J. Brzezinski acted as secretary.

2. Definitions

Several definitions given in the report of an earlier meeting[1] were reviewed and agreement was reached on the following terms, for the purpose of the discussions:

Monitoring. This implies the collection and recording of data on health or on environmental parameters and it may take place in isolation from surveillance.

Surveillance. This is the use of monitoring data after collation and interpretation, to determine suitable action for the protection of human health. Surveillance therefore cannot take place in the absence of monitoring systems. Thus surveillance can provide information for decisionmaking in the field of disease control.

Surveillance was considered to be distinct from etiological studies. Though both may involve the performance of measurements over time, surveillance is not designed to test specific hypotheses nor, generally, is a separate control group required: its purpose is the interpretation of changes in descriptive observations.

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[1] WHO Regional Office for Europe. Epidemiological surveillance of long-term health effects of environmental hazards, Report on a Working Group, Copenhagen, September 1974. Copenhagen, 1975 (document EURO 4905(8))

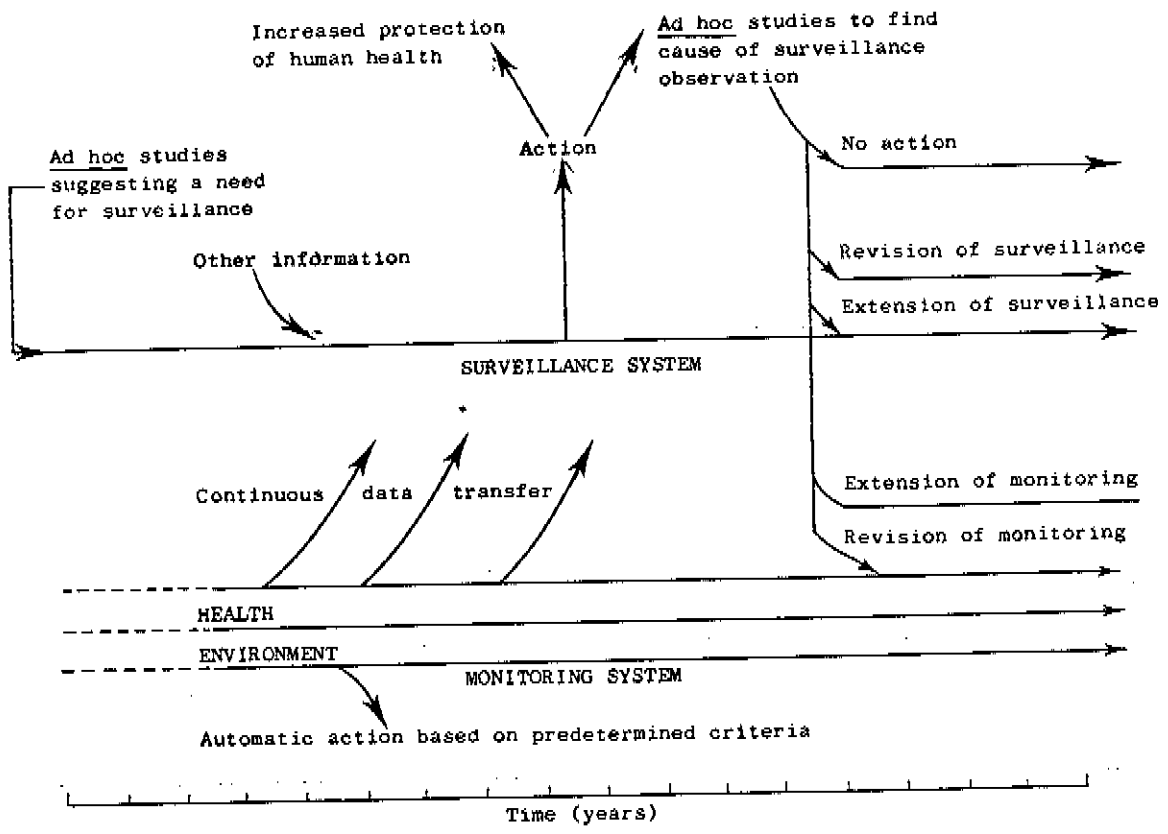
Fig. 1 shows the relationship between monitoring and surveillance systems and also the role of ad hoc studies. An arbitrary time scale of years is used. The diagram shows that monitoring systems may have existed before the introduction of surveillance of health and environmental hazards. Such systems are designed to function when certain preconditions are met: e.g. sickness absence data are often collected to determine what social security benefits should be paid; public warnings are issued when environmental monitoring shows that certain levels of pollution have been reached. This action does not require the interpretation of data but is taken automatically according to predetermined criteria. Surveillance is usually undertaken when its need is indicated by the results of etiological studies, by chance observation or because of a known relationship between health and a hazard found in animals. Information for surveillance is furnished continuously by the monitoring systems. When a change in the levels of the data occurs which, when interpreted, indicates a need for action, active steps may be taken to return the environment to its original state or to protect human health in some other way. If the change in environmental or health data cannot be explained, ad hoc studies may be conducted to determine the causes. The studies may show no real relationship between changes in the environment and health, in which case no action is taken, or they may suggest a need for revisions and extensions in the surveillance or monitoring systems.

Etiological studies. These differ from surveillance in that they are designed to test specific hypotheses. It is through such studies that evidence of causal relationships between environmental agents and effects on health is usually obtained.

Environmental hazards. They are chemical, physical or biological agents or social factors introduced into the environment by man, which are known or are likely to be hazardous to health.

Effects on health. These are changes in health of physiological or pathological significance. In general the effects are expected to be deleterious to health but the possibility of improvement in health status was kept in mind during the discussions.

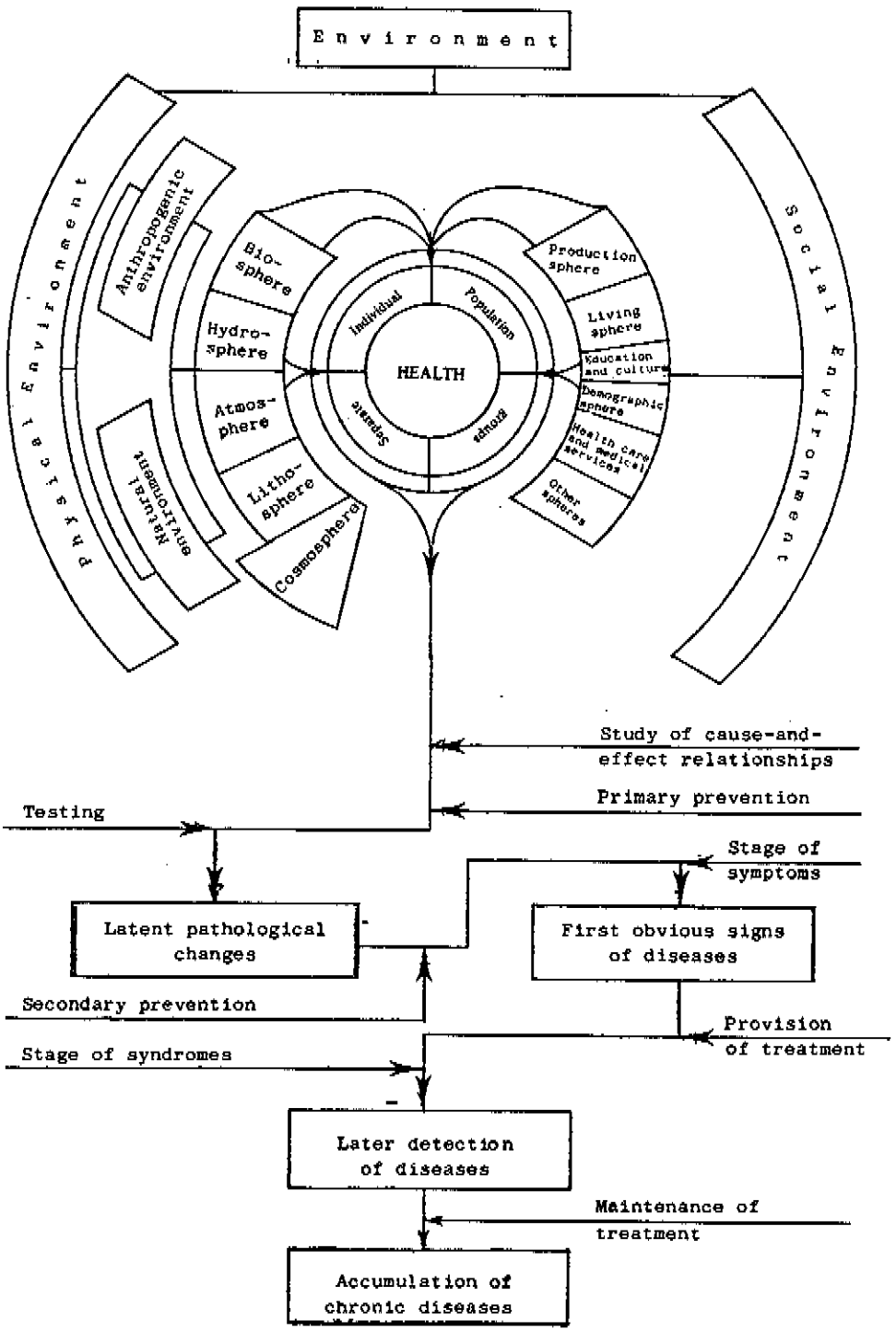
Fig. 1 RELATIONSHIP BETWEEN MONITORING AND SURVEILLANCE SYSTEMS



3. Relationship of the environment and health

Fig. 2 is a model of how the physical and social components of the environment affect health. All aspects of the physical environment are influenced by natural and man-made forces. The social environment consists of a variety of subsystems within the structure of a community, some of which are shown in the model. All these subsystems affect the health of individuals or groups.

Fig. 2 CONCEPTUAL MODEL OF THE INFLUENCE OF THE ENVIRONMENT ON HEALTH



Cause and effect relationships between environmental factors and health status may be found through special studies or, sometimes, by chance observation. The findings may lead to the development of schemes for primary preventive measures such as control of industrial emissions. If primary prevention is not completely successful, secondary prevention at the individual level may be necessary through detection of disease by screening or case-finding with subsequent treatment of those found to be ill. When such preventive measures are unsuccessful, symptoms and pathological changes occur which, if treatment is not curative, lead to an increasing burden of chronic degenerative disease.

In the health care systems of many countries greater emphasis is now placed on the factors at the higher level of the model.

4. Surveillance methodology

In surveillance systems where health effects and environmental hazards are analysed, it may be helpful to have a precise idea about both so that they can be monitored together and changes in one be related to changes in the other. This procedure ensures efficiency, with minimum waste of effort and outlay, but is highly specific to the agent in question. The alternative is to determine health status using general data such as the rates of hospital admission, diagnosis, sickness-absence from work, reportable disease incidence or mortality (all of which are often routinely collected and no additional expenditure would be required) and to measure suspected hazards in the environment, any one of which might be a threat to health. Changes in one measure may be reflected by changes in the other and, after suitable analysis, could provide information for surveillance of the effects of the environment on health. When the effect of an agent on health is not known, epidemiological studies are needed to define the problem at a level of precision which cannot be obtained using crude surveillance data collected for some other purpose.

If surveillance is to be cost-effective, the design of the system and the selection of variables for which data are to be collected must rest on reasonable scientific evidence that there exists a cause-and-effect relationship between hazard and health status. As already pointed out surveillance is unlikely to be undertaken until ad hoc studies have shown that a risk exists. These studies may have been carried out on living organisms other than man and may follow epidemiological investigations.

The Group discussed the general principles for setting up a surveillance system.

4.1 Objectives

The objectives of a surveillance system must be stated before the detailed design is formulated. In general the objective should be to observe changes in the health status of population groups in relation to changes in indices of environmental hazards. The system should be able to identify and distinguish between acute, chronic and delayed effects of the hazards.

More specifically new surveillance systems, though they may be based on previous ones, should be tested in pilot form to assess their feasibility, to estimate their costs, to determine their usefulness and to solve the problems of linking data for different time periods. It should be determined whether they can detect adverse effects on health more rapidly than relevant mechanisms already in existence.

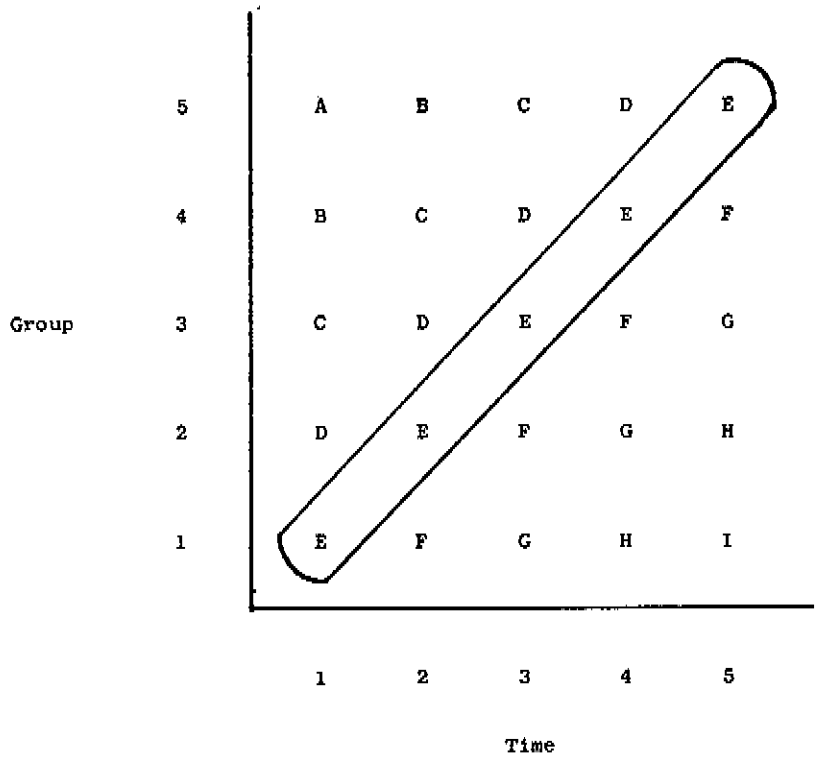
4.2 Design

The general design of a surveillance system is similar to that of a cohort study, except that the population in the former is usually specified such as that of a factory, a town or a nation. It is recognized that there is migration of individuals in and out of the population, but those leaving would not normally be followed up while those entering would come under surveillance. Thus in this respect surveillance differs from a cohort study.

The mixed-longitudinal design has both the simplicity of surveillance and the advantages of a cohort study. It is applicable to fairly readily-defined populations such as those found in an industry, school or other institution.

The mixed-longitudinal study is so called because it comprises a cohort (longitudinal) study within a series of cross-sectional studies carried out in the same general population at predetermined, though not necessarily equal, time intervals. Fig. 3 shows this design.

Fig. 3 SCHEMATIC REPRESENTATION OF A MIXED LONGITUDINAL STUDY



There are five groups in the study sample, defined by age or some other characteristic which changes with time and according to which the sample is chosen. These five groups (A to E) are seen at time 1. When the population is seen at time 2, all those in group A seen at time 1 have left, but have been replaced by those in group F. If there has been no loss in the other groups, the same individuals should be present as at time 1. This process may continue for as many time periods as desired. From the diagram, it can be seen that most of the groups have been followed for two or more periods and thus form distinct cohorts. The data can be analysed longitudinally by cohort or by group (i.e. different people at each time period) or cross-sectionally. In the cross-sectional analysis, care must be taken in the interpretation of findings obtained in repeated samples of the same people.

An example can be taken from work in schoolchildren. The groups could be the classes drawn up according to the children's ages and the time periods could each consist of one year. From one year to the next the children in the top class leave the sample and it is joined by those entering the lowest class.

Using this technique, it is possible to analyse the first set of data immediately to determine whether a health effect can be associated with an environmental hazard and, over time, whether there is any difference in the reaction of a given cohort to the hazard, due either to changes in the former or alterations in the level of the latter.

In this design no control or unexposed groups are specifically established. Comparisons are made between data collected at different times. Action may be taken when there are associated changes in health status and level of environmental hazard. In this way the population acts as its own control, provided it does not change between observations in other ways which might affect its health status, e.g. emigration of the young with replacement by the old would change the crude mortality rate. However control groups can be defined post hoc as those under surveillance who are known not to have been exposed to the hazard.

A pilot scheme should be undertaken before a complete surveillance system is established.

4.3 Target population

The population to be observed must be selected according to the expected effects of the environmental hazard. It may be a group defined by an activity such as going to school, working in a particular industry or attending a specialized clinic; if appropriate, general populations may be used. If the total population is not observed, statistical sampling will be required. In some cases populations which are at particularly high risk may be suitable; these include occupational groups working with hazardous substances and particularly sensitive groups such as asthmatics or chronic bronchitics. Pregnant women also form a high-risk group - the hazard may affect the women themselves or have effects in the form of excess abortions or stillbirths, or unusual or excess congenital malformations.

Although accurate assessment of change in health status normally requires that close attention be paid to ensure sound statistical sampling of the observed population, in the case of surveillance the sample is usually not required to represent closely the population from which it is drawn. Nevertheless the sample should be constituted in such a way that the chance of detecting an effect is maximized.

4.4 Health status monitoring

While the health of a group may be monitored in a variety of ways, there are two main sources of information. First, data on health may be collected routinely for purposes other than surveillance. Mortality records are kept in almost every country and, if comprehensive, are a valuable source of information. Morbidity data may also be collected on a national scale but, because of difficulties in ascertainment and lack of precision in diagnosis, they may not always be suitable for surveillance of long-term effects. Such data collected on a smaller scale as in industry or in the educational system may be useful. However data from disease registers (for congenital malformations, cancer, coronary heart disease) is likely to be the most useful because particular attention is paid to ascertainment of all cases and to determination of the exact cause of morbidity and death.

Second, there are monitoring systems designed specifically for the type of surveillance required. If a new system is adopted, a complete set of data relevant to the population at risk is collected. It is unnecessary to make the compromises imposed by the use of existing systems. However new systems are likely to be expensive to set up and maintain.

In order to determine the part played by the health effects which are under observation, it is necessary to have a general appreciation of the health status of the population. Existing systems may provide this information or the basic monitoring may have to augmented to include indicators of aspects of health other than those of direct concern.

4.5 Environmental monitoring

The need to use existing systems for the surveillance of long-term health effects is far greater in the case of environmental monitoring as compared with health monitoring. Since the effects are expected to occur some years or even decades after the initial, or perhaps the sole, exposure to a hazard, it is necessary to link data on past exposure to present health status. Many of the current environmental monitoring systems were not intended for use in conjunction with health information systems so the combination of data from both sources may be difficult. It may therefore be more immediately useful if health monitoring is adapted to suit existing environmental systems rather than the reverse.

As new potentially hazardous substances enter the environment, they must be monitored immediately if their long-term effects are to be assessed in the future.

Estimates of exposure of individuals to a hazard will be approximate if only the general environment is monitored. For example the levels of atmospheric pollutants differ greatly when measured outdoors as opposed to indoors. Hence, as people spend a large proportion of their time indoors, outdoor measurements give only a rough indication of exposure. Similarly exposure to pollutants in drinking-water varies according to the quantity drunk and the type of food eaten. Where more precise estimates of exposure are required, biological monitoring may prove satisfactory for substances that are retained in living tissues.

The Group felt that, together with a general view of the health of the observed population, a general view of environmental pollution should be obtained. In that way it would be possible to detect exposures to multiple hazards and to relate them to health effects singly and in combination; and this would provide a basis for demonstrating synergistic and unexpected effects on health.

4.6 Timing

The speed with which a surveillance system reveals a hazardous situation depends on the frequency of sampling and the type of health data used. The necessary frequency of sampling may be determined on the basis of the time elapsing between first exposure to a hazard and appearance of the effect. The use of aggregated data in which health status and other characteristics are defined for groups rather than individuals may speed collection and analysis.

4.7 Data collection

If possible, data collected for surveillance should be subject to the same controls as those used for etiological studies. The validity of the methods of measurement must be established either from past evaluation or by ad hoc studies. The methods must be stable over time so that observed changes in health or environment are not merely a reflection of changes in the measuring instrument or the observers. Long-term quality control should be incorporated into the monitoring systems.

If international comparisons are to be valid, the quality control requires a more complex administration than in the case of regional or national systems; and the methods used for measurement of the hazard and its effect on health must be harmonized.

5. Surveillance schemes

The Group reviewed the existing environmental and health monitoring systems in their own countries. Although the geographical coverage and details of the data collected vary, there are systems for air, water, soil and food and, in the health field, for national and local mortality, morbidity and cancer registration. Other registries also exist in some countries and the Group felt that those devoted to congenital malformations and abortions were of particular interest.

In new surveillance schemes, use would have to be made of environmental data collected in the past. For this reason existing monitoring systems are thought likely to form the basis of the environmental input for surveillance. As the monitored substances differ from one country to another, the Group did not think it helpful to list sources of data in the same way as for health. In pilot surveillance schemes, the selection of environmental hazards for monitoring might depend on local circumstances, any chemical, physical or biological hazard or social factor on which data were available being considered for inclusion.

Various data on the health of suitable populations were suggested as being potentially useful for surveillance. These include information on patients discharged from hospital and in general practice, occupational health records, short-term and permanent disability records, and data from repeated mass screening projects, disease registries, health monitoring surveys and the data bases of scientific institutions. Other data about the populations would be required, including socio-economic information, which could be linked to either group or individual data or health. These data should include information on factors which promote as well as endanger health.

5.1 Pilot surveillance scheme

The selection of suitable pilot schemes to develop long-term surveillance suitable for international application is hampered by the lack of information on existing environmental monitoring systems. The report of the earlier working group[1] made special mention of the need for central collection of the wide range of environmental information published within countries and a summary of the activities. However, although summaries are now available in a few countries, there is insufficient information on which to base the choice of pilot scheme.

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[1] WHO Regional Office for Europe. Epidemiological surveillance of long-term health effects of environmental hazards, Report on a Working Group, Copenhagen, September 1974. Copenhagen, 1975 (document EURO 4905(8))

Three schemes were considered. The first would be concerned with the surveillance of health as monitored by hospital discharge diagnoses in relation to environmental measurements reported nationally or by the local authorities in whose areas the hospitals are situated. With regard to the second scheme, covering the relationship of atmospheric pollution to respiratory or other disease, it was felt that as there is so much work going on in this field at present it would not be appropriate for new surveillance programmes. The third scheme involves the collation of data collected routinely in registries (particularly of congenital malformations and abortions) with environmental data. In existing registries, the scope of the data collected on each person could be enlarged to include environmental exposures of the mother before and during pregnancy. In newly developed registries this type of information should be part of the basic data. The Group felt that this scheme would be more sensitive in showing the effects of many environmental hazards than the other two and accordingly recommended it for implementation.

6. Summary and recommendations

The Group discussed global and national environmental monitoring systems, aspects of pilot studies such as objectives, design, target populations and sampling, geographical areas for studies, timing and collection, analysis and use of the data.

During the discussions a distinction was drawn between monitoring and surveillance. Monitoring implies the collection and recording of data on health or on environmental parameters whereas surveillance implies the use of these data, after collation and interpretation, to determine suitable action for the protection of human health. Such action may include the organization of ad hoc studies to determine the cause of unusual surveillance findings.

A distinction was also drawn between surveillance and etiological studies. Though both might involve repeated measurements over time, the former is not designed to test specific hypotheses nor is a separate control group generally required; its purpose is the interpretation of changes in descriptive observations.

A review of monitoring in the participants' countries indicated that national monitoring systems have existed for hazardous agents in air, water, soil and food. Data on mortality and morbidity and registries for cancer and congenital malformations are also available though not necessarily at a national level.

However the data from environmental and health monitoring systems have rarely been combined for surveillance. Often the data derived from one system do not apply to the same geographical area or population as another so their use for combined surveillance has been limited. The Group felt that this situation should be improved, particularly where new monitoring systems are being introduced.

The Group considered the schemes for surveillance of the long-term health effects of hazardous agents in the environment that might be proposed. The objective of such schemes would be to detect changes in the health status of a population which might be due to either contemporary or previous changes in the environment. For this purpose, present health data would need to be linked with present and past environmental data.

Various data on suitable populations were suggested as being potentially useful for surveillance. These include information on patients discharged from hospital and in general practice, occupational health records, and data from mass screening projects, disease registries, health monitoring surveys and the data bases of scientific institutions.

The health data should be linked to data on chemical, physical and biological agents and social factors derived from any environmental monitoring scheme. Data on factors promoting and deleterious to health should be used in surveillance.

Having in mind the diversity of problems related to the sources of health and environmental data in various countries and the urgent need to develop the methodology of long-term surveillance of health effects, the Group considered that the most appropriate pilot scheme would be on the surveillance of congenital malformations and spontaneous abortion.

The following recommendations were made:

(1) Encouragement and support should be given for:

- the linkage of data collected for monitoring of health and the environment,
- the exchange of health and environmental data to facilitate international surveillance,
- international cooperation in the development of pilot surveillance schemes and comparison of their effectiveness and utility.

(2) Working groups and meetings should be convened to develop surveillance systems mainly using existing environmental data and health data from the following sources:

- hospital discharge records,
- general practice,
- occupational health records,
- records of short-term and permanent disability,
- mass screening,
- registries, e.g. for congenital malformations, cancer, childhood malignancies,
- health monitoring surveys and the data bases of scientific institutions.

These data should be linked to data on chemical, physical, biological and social agents in the environment, as available.

The Group felt that priority should be given to the development of a surveillance system in which congenital malformations and spontaneous abortion would be related to environmental factors.

(3) Agencies and institutions concerned with the collection of information derived from the monitoring of health or environmental hazards in defined areas on populations should be encouraged to:

- use an appropriate methodology in the data collection,
- pay special attention to the validity of the data collected,
- store the data in view of their potential value in the investigation of the long-term health effects of hazardous agents.

(4) To improve the analysis of surveillance data and the quality of resulting action, support should be given in developing a methodology for studying the relationship between exposure to multiple environmental agents and multiple effects on health.

ANNEX I

LIST OF PARTICIPANTS

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[1] Participation expenses not paid by WHO.

Annex I

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