WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR EUROPE

ORGANISATION MONDIALE DE LA SANTÉ
BUREAU RÉGIONAL DE L'EUROPE

ВСЕМИРНАЯ ОРГАНИЗАЦИЯ ЗДРАВООХРАНЕНИЯ
ЕВРОПЕЙСКОЕ РЕГИОНАЛЬНОЕ БЮРО

EUROPEAN CONFERENCE ON MEDICAL COMPUTING

Report

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1. Introduction

The demands of health care management and epidemiology in the twentieth century have called for the large-scale handling of data and statistics. Computers were quickly brought into routine service in the field of medicine, and, with the development of on-line real-time processing, the possibility of their use in the direct care of patients or in the day-to-day management of health care units has been of interest to many health authorities. But developments are complex and expensive, and marked, until recently, by almost as many failures as successes. Isolated independent effort seems a poor way of embarking on this course of development, and from an early date the WHO European Office has actively concerned itself with this field, particularly by organizing meetings for discussions, by providing expert consultant advice to countries or by the award of fellowships for the study of computer developments throughout the world.

Since 1964 a series of discussion meetings for Member States has been organized by WHO, to consider practical applications of computers to health administration (1), health statistics and medical research (2), public health (3) and in hospitals (4).

At its eighteenth session in 1968, the Regional Committee for Europe adopted a resolution requesting the Regional Director to continue to give active consideration to developments in the field of medical computing. As a result, a working group of experts was convened in Bratislava (5) to outline possible new activities for the European Office. The Conference on Medical Computing was convened as a direct outcome of that meeting.

At the invitation of the Government of Luxembourg, the Conference met from 10 to 14 July 1972 in the Kirchberg European Centre. It was attended by 24 participants and 8 temporary advisers from 21 countries. A representative of the International Federation for Information Processing (IFIP) attended part of the meeting. Opening the Conference, the Minister of Health of Luxembourg reminded participants of the ever-present duty to reconcile the potential of automation with the rights of the individual, the patient.

Dr F.A. Bauhofer, Director of Health Services, WHO Regional Office for Europe, thanked the Minister, the Government of Luxembourg and Dr E. Duhr, Director of Public Health of Luxembourg, for their warm hospitality and for the excellent facilities, and outlined the earlier work of WHO in this field. The Conference elected Mr D. White Chairman, and Dr J.C.A. Raison Rapporteur.

The agenda of the Conference is given as Annex I, the list of working papers as Annex II, and the list of participants as Annex IV.

2. Scope and purpose

The primary objectives of the Conference were:

(1) to state the needs of Member States in relation to their development policies;

(2) to describe the benefits to be derived from WHO activity in medical computing;

(3) to advise on priorities and indicate the resources required.

A secondary aim was to contribute further to the advancement of medical computing both internationally and within Member States.

It was asked whether there should be a specially directed effort in this field, bearing in mind the individual computing interests of WHO Divisions such as Health Statistics. The work already performed by the WHO European Office in organizing meetings, providing consultants for survey purposes or to establish computing activities, and the provision of fellowships for study abroad by health care staff of many disciplines, was recognized. However, the influence of computers, both because of what they can be used to do, and because of the improving effects on health organization and management which planning for their use causes, permeates so widely through

all parts of practical care, management, planning and research that continued and increasing attention should be given to the introduction of this technology. There was a strong call from all sides for a supranational effort to be made now if the contribution which computers can make to health and treatment is to be timely. As was agreed at the Pan American Health Organization Committee on Medical Computing (6), "Countries' efforts are directed towards planning their activities, rational utilization of resources to provide greatest possible yield, and to improve the method of health care provided to the individual....and to support these measures it is essential to have information systems" from the patient-doctor level, through progressively larger units of care to a regional or national level. In modern terms this makes the use of computers inescapable. Yet it is unreasonable to contemplate the cost of the potential of this tool if its use is to be developed in an uncoordinated manner, almost randomly, as required for specific functions in isolation, with no correlation of the many interactive procedures it can and will perform. The Conference endorsed the view of the Bratislava Working Group that WHO assistance in this subject should help:

(a) to even out the pace of development between countries;

(b) to prevent unnecessary duplication of effort in a field where development is very expensive and skilled staff are short;

(c) to facilitate progress towards standardization, thereby reducing individual countries' efforts, to improve the efficiency of systems which are developed because of the wider experience on which they are based, and to improve the use of information by establishing similarity in types of data and processing;

(d) to reduce costs for Member States.

These benefits, while of advantage to all, would particularly aid progress in less advanced countries.

3. Developments in Europe

The Conference received oral and written statements by participants on the situation with regard to medical computing and its relation to health care organizations of the respective countries, which illustrated a wide range of differences affecting this subject.

A small number of examples selected from the individual reports will illustrate facets of this variance, but no attempt will be made to be comprehensive, in respect either of activities undertaken or of countries reporting such activity. There are, of course, very many similarities in conditions of health care administration, systems, and priorities in Member States which impinge upon national interests in medical computing. In the USSR and the United Kingdom there is a substantial or complete national organization of health care and central health authorities not only exercise a very considerable influence over computer developments and the balance of effort, but also assist greatly or control co-ordination between research development and service implementation. This calls for a well developed central understanding and expertise in many aspects of the subject, medical, technical and user-oriented. Other countries, e.g., Norway, have strong central interest in development, but very limited control of this, in the largely independent hospitals, for instance. In Finland there is no central planning of computer developments.

Where a government does exercise control, through a department, there is variation in the advisory services which it employs. Special advisory groups exist in Norway, England and Scotland. In the Federal Republic of Germany there is a Medical Information Processing Group of the Data Processing Advancement Programme (which is the concern of the Ministry of Science and not as is more usual, of the Ministry of Health).

All countries have considerable interest in computer services associated with the management of public health and the use of health care resources, i.e., in data-gathering systems for regional or national purposes, but this is greatest where central government is responsible for the provision of health services at large (USSR, Bulgaria) or for parts or substantial elements (France, Sweden). In other countries this interest may reflect the requirement to obtain real evidence of use of medical care, and, perhaps, need. Centrally promoted, or regionally promoted computer-based

systems of information about aspects of the public health, such as the state of immunization (in local authority areas of the UK) or cancer registers (Norway, UK), may be developed beyond the mere information-compiling stage to be of assistance in the actual provision of the associated medical care, e.g., by recalling patients.

Since hospital care absorbs a very large part of any nation's health costs, and this is the element of health care in which most Member States have either complete or very substantial financial involvement, it is not surprising that this is the field of care which receives most attention in regard to computer developments. The degree of interest and development is very varied. It has also been said by those examining the potential of the most "advanced" computer methods, i.e., multi-access, multiprogramme rapid-response real-time systems, that such systems must be dedicated to, or centred upon, hospitals where there is a sufficient volume and complexity of fast-changing, inter-related data-handling activities occurring to justify the cost and effort of development.

Many countries are conscious of the inadequacy of existing methods for recording clinical and hospital adminstrative elements, and of the need to attain systemization of this before much can be done by computing. In Finland, for instance, efforts are at present concentrated on standardizing this record. Most activity is therefore confined to hospital event recording, based on some form of discharge summary (Norway, Hungary) which has usefulness for management in medium-term and long-term planning by showing the use of resources and perhaps by providing data for simulation studies. Data-handing requirements within hospitals are for recording, communication, and control, and it is the ambition of computer systems going beyond mere event recording, to give services in all of these as well as to produce higher-level management and planning information or incidental by-products of such systems. The concept extends as far as "Total Hospital Information Systems", an early goal that has, as yet, been attained by none. In Sweden a long-established project has been concerned with the hospital record, notably its medical aspects; another is concerned with real-time recording of basic information on the provision of services to a hospital population and that of its associated region. This, and projects in the UK and the Federal Republic of Germany, are based on the use of computer terminals, often visual display units and keyboards, at many of the action points, e.g., wards, in a hospital and involve fast computer response. Most of these systems are just about to go "live". In France, the Assistance publique already has an effectively operating recording, requesting and reporting system based on frequently collected computer-readable documents and on information frequently distributed from a fast turn-round batch processing system. An interesting application in which the computer co-ordinates community need with hospital facilities is being developed in the USSR: the system determines the best hospital unit to which to send a medical emergency patient in the light of such features as the nature of that emergency, its location, the location of ambulance facilities, and the state of relevant hospital facilities at that time.

Considerable effort has been made where computers may impinge more directly on medical care processes, particularly where the computing can most suitably be carried out on a dedicated small or mini-computer. Perhaps the greatest extent of such development is in laboratory services, where computing has been involved, both with the instrumental measurement and calculation processes and with the data-handling problems arising when many requests are received and many reports issued. Such work is apparently being undertaken in most of the Member States. Governments have differing degrees of interest in such developments, depending largely on their own responsibility for providing laboratory services.

In France, Sweden and the UK, on-line computing systems are in use or being developed for the planning of radiotherapy treatment and the interpretation of electrocardiograms. The less developed use of computers in monitoring the condition of the critically ill is reported in Sweden and the UK.

For those concerned in all this work, one of the greatest stumbling-blocks is the ascription of data elements to the person with whom they should be associated, and the linking of such data, relating to any individual, which has originated in different places. Accurate patient identification is technically feasible; the barriers are organizational or attitudinal. In the descriptions of very varied sorts of computing activity achieved, and even of varied goals, the immense systematic advantage which lies in the regular use in Denmark, Norway, Sweden and Finland of unique personal identifying numbers for the whole population was evident; an advantage which is perhaps the great envy of developers in other countries where there is no lack of computer resources, ability and

enthusiasm. The planned or possible build-up of a lifelong information system based on the health state of the individual and on his requirements from all parts of the health care system from the time of birth is recognized as perhaps the optimal course of health-care computing development.

4. Education and training

All the participants recognized a very great need for adequate training of both "conceptual" (appreciation courses) and technical types, for managers, users and computer technologists. In this connexion there is psychological antipathy to be overcome. Courses must range from basic to advanced, and must be finely tuned to match the particular needs of the individual; they must be appropriately timed. A number of participants gave examples of introductory courses of about 20 hours for medical students. There is still a dearth of interested doctors, and if the interest of 10% could be captured, great benefits could be obtained. The same duration appears to be adequate for management, and for staff in the health field who may need to use computers in their business. Doctors and others specializing in information systems need training, in association with other related subjects, over a period of 2-3 years. Computer technologists and systems analysts from outside the health field need careful and full introduction to the subject by able and experienced health

Experts, particularly doctors, in this field, are in short supply, but if training is left largely in the hands of data-processing experts, it was suggested, psychological antipathy may give rise to a situation where doctors may prefer to go without the use of computers rather than be overwhelmed by non-medical experts.

It is self-defeating to provide for the education of health professionals, say through Fellowships, if they cannot in return be provided with the facilities to apply the experience they have gained.

Advice and help is needed in the development of adequate courses and modern methods of teaching and in the provision of teachers, particularly those with a health services background. The use of computers for teaching in this subject probably requires more teaching manpower resources than direct person-to-person instruction. The dissemination of information about education and training, and the success of various methods, is one of the aids most wanted by many countries.

It was therefore recommended that progress could best be aided in the following ways:

(1) By the individual or collective action of Member States

(a) Participants should try to influence governments of Member States to recognize the importance of education in this field.

(b) Meetings and courses in general and specific aspects of medical computing should be organized by Member States for all kinds of staff, preferably in academic environments or alongside major medical projects.

(c) Similar meetings and courses are also required to promote improved teaching methods in subjects related to medical computing.

(2) By WHO organizing meetings, study groups or courses

(a) The Regional Office should support the establishment and running of courses in general and specific aspects of medical computing by Member States, collect and disseminate information about such courses and provide teachers from other countries to assist such courses.

(b) The Regional Office should organize meetings to discuss and promote improved methods of teaching in relation to medical computing.

(3) By the provision of WHO fellowships

WHO should continue to help progress by furnishing study fellowships. (It has been observed that expert knowledge in the field is lost if fellows do not have the opportunity to apply it practically, and governments should seek to ensure that operational facilities are made available to fellows on their return to base.)

(4) By the provision of specialists by WHO

(a) to assist in arranging or teaching for courses in aspects of medical computing;

(b) to improve teaching methods in medical computing.

(5) By WHO directly

If WHO is able to establish a special team for medical computing, its information service on all subjects will contribute greatly to education in the field.

5. Information and advice

The thirst for information about, and help in, computing developments is universal and insatiable. The gulf between ambitious narrative description and experienced knowledge in this field is very large, and it became clear at the Conference that one of the main interests of participants was to acquire reliable information to aid developers and to counter the extravagances of enthusiasts or salesmen. Needs are great but fundamental and central to all other developments. Prime among these is the setting up of an international information service. This calls for a special team, and the difficulties of establishing a comprehensive service were instanced by some countries which had set up or were associated with such services. However, use might be made of such national services, and of the experience of consultants sent to assist Member States' computer projects, as a first source of material for dissemination. WHO had set up a special office, in May 1972, with data processing as one of its particular interests, and growth of an information service from this is a possibility.

Fig. 1 illustrates how the provision of information and advice, perferably by a central team of experts and with assistance from them or from consultants, integrates all the recommendations developed at the Conference.

It was recommended that the work of providing information and advice should be promoted as follows:

(1) by Member States individually or collectively

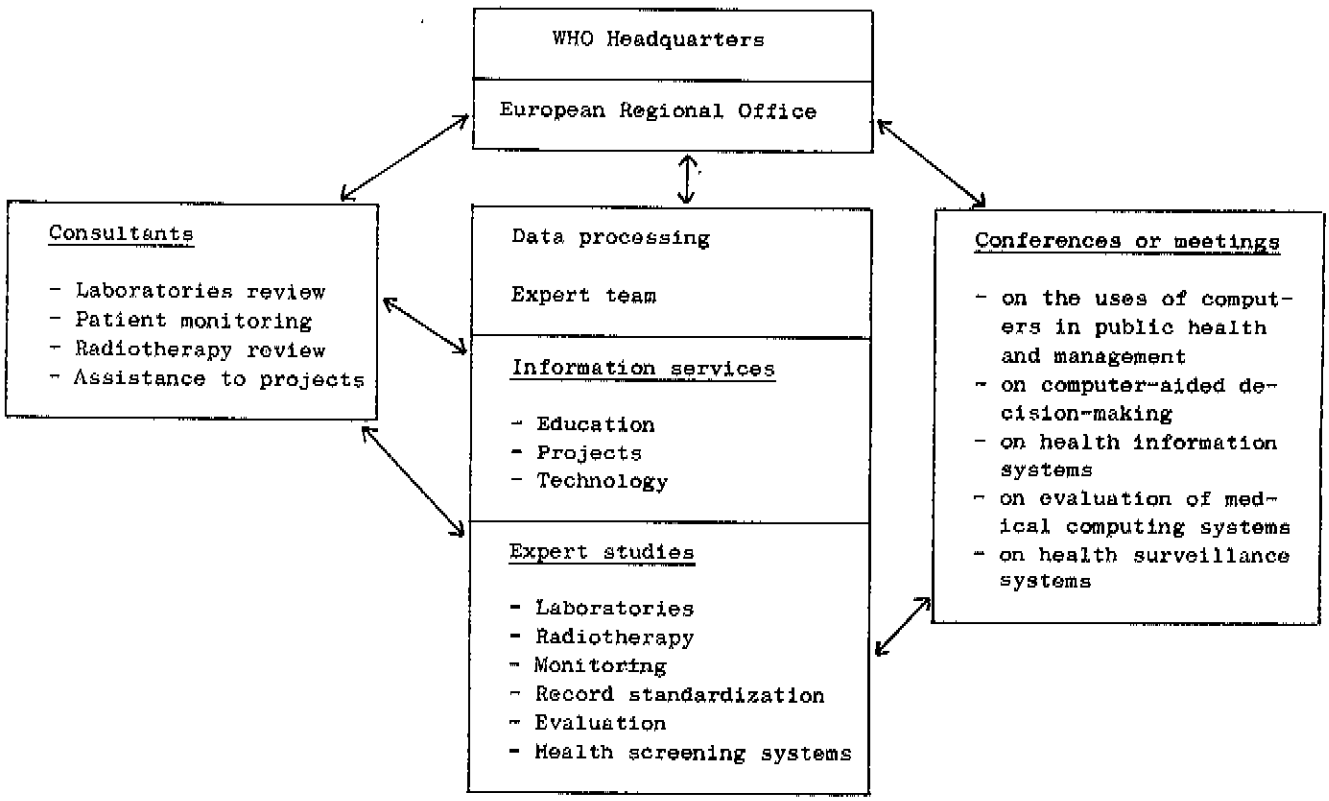
(a) Member States should actively support the function of a WHO information service, if this can be set up for developments in medical computing, by regularly collecting and passing to WHO data from their own sources.

(b) Failing the establishment of a WHO information service, Member States should collect and distribute among themselves as much information as possible about medical computing work.

(c) The provision of consultant services to Member States by WHO is of great benefit, and countries may consider financing the provision of such services.

Fig. 1

ORGANIZATIONAL STRUCTURE ILLUSTRATING THE RELATIONSHIP BETWEEN VARIOUS RECOMMENDATIONS OF THE CONFERENCE



(2) by WHO consultants

The services of WHO consultants would help in solving specific problems of Member States in the development of computer-aided health care systems.

(a) to study the use of EDP in medicine by Member States;

(b) to collect information on potentialities and requirements of computer equipment in projects with which consultants are associated;

(c) to study, analyse and evaluate experience from completed and operational health information systems projects which the consultants have assisted;

(d) to draw up recommendations for standardization in projects in order to minimize unnecessary duplication;

(e) to estimate costs of research, design, personnel training, as well as installation, accommodation and operating costs.

(f) to analyse and evaluate the use of such consultant services and the experiences of consultants.

Member States which request WHO to provide consultant services should, whenever possible, cover part of the expenses involved.

(3) by WHO

The Regional Office should continue to promote meetings at which health and computer personnel discuss the development of computer-aided health services systems and procedures. Subjects should include the use of computers in the following fields: public health services, health planning, hospital care, patient care evaluation, laboratories, and general practice, but the subject matter and agenda need to be defined precisely, participants should be chosen so as to ensure strictly relevant discussion, and the reports of the proceedings should be more widely disseminated.

WHO should establish a team whose function would be:

(a) to collect and disseminate scientific and technical information on ongoing projects, particularly those assisted by WHO consultants, on:

(i) the extent to which EDP is used in medicine in the Member States of the European Region and possibly in other regions of WHO;

(ii) potentialities and requirements in respect of computers used in specific projects;

(iii) experience of the operation of ongoing projects;

(iv) the cost of implementing the various stages of projects, operation of computer systems, etc.

(v) training courses in medical computing;

(b) to prepare scientific and technical information on the questions mentioned above and to communicate it to the Member States of the European Region, as well as to any other States that may request such information;

(c) to inform Member States of all courses, meetings, symposia and conferences on the question of the use of EDP in medicine, which are open to international participants;

(d) to disseminate information on computer-aided health surveys, including:

(i) lists and brief specifications of operational multiphasic programmes;

(ii) lists of experts in this field;

(iii) research methodology and results, and

(e) to provide information accumulated by the information service to international information (reference) centres, on the basis of mutual agreements. This information service should consist of specialists experienced in organizing information and reference services and computing centres. Links with the International Computing Centre (ICC) and with WHO Headquarters would be established by the Regional Office.

6. Medical records

Although the title is apparently self-descriptive, it covers a variety of records which may be handled by computers, from those containing substantial or even complete clinical health and sickness data to those composed largely of identification and social status elements with abbreviated entries indicating one or a few episodes of prophylactic or therapeutic treatment, or illnesses. Even the latter record, which may be essential for unit, departmental, hospital, area or higher management, is a subject of sensitivity in relation to its confidentaility.

Although it is possible to input and retrieve free-form (narrative) records to and from computers, and it is possible to manipulate such records, the implications in the near future are

costly and the utility of stored data items, in terms of potential for analysis, may be severely limited. Standardization of records, in form and elements, certainly facilitates progress in medical computing, and increases the uses of what has been recorded, but it calls for considerable systematic thinking and agreement by users to develop satisfactory data codes, and may be seen by some as an unnecessary technological shackle. Any attempt to organize medical computer records must, therefore, provide security of confidentiality to the limit expected by educated public opinion, and steer a course between disorganized free-form methods and regimentation. The purposes of standardized records may seem obscure to the practising physician concerned principally with the care of the individual patient, although the increasing complexity of modern diagnosis and treatment, and the advent of "teams" concerned with an individual's treatment, are at last having the effect of introducing degrees of standardization in form, even in written records, as evidenced particularly by the growing interest in problem-oriented records.

The advantages of standardization are:

(1) improved communication of information between persons or units of health care;

(2) linkage of data elements compiled or stored in different places (the integrated personal health record);

(3) the obtaining of abstracted (depersonalized) data for management analysis, e.g., epidemiology studies;

(4) reduced costs.

The standardization of records is at once the goal and the problem in the successful development of medical computing. It can be achieved at health care unit level (e.g., cardiac disease), national level (various forms of hospital activity analysis have been developed) or internationally (ICD, CIOMS), each level increasingly hard to achieve but increasingly valuable. Individual (patient) identification has been standardized in countries where a national number system exists, and this certainly provides the best base on which to build a health information system, but there are techniques for identification, dependent on population size, which may be used in computer systems if this is not available.

So far as medical data is concerned, progress has been easier where the data are numerate (laboratories) or fairly easily systematized, preferably in a monothetic classification, and of limited size. The key elements of the medical event (complaint, diagnosis, treatment and drugs given, operations, outcome) are most needed in standardized form. Until an economic and very effective breakthrough occurs in the handling of non-formated records, perhaps as much as 80% of the medical record should eventually be standardized.

Components of a computer-based medical card should not be designed in isolation from other possible computer applications which might use the same data, but should take account of any such applications which may be later introduced. The development of standard terminology increases the depth of understanding between health care staff, and should be included in medical school teaching so that acceptance increases with successive generations.

Present experience shows the difficulties of achieving standardization even at national level, and too rapid movement may impede progress because of resistance. But the advantages are already recognized where elements of the record have been standardized internationally (ICD, CIOMS) or in some medical specialities (SNOP), which justify continued determined effort in this direction. To some extent, the interests of supranational authorities in standardization will promote national endeavour, and there is also an important international role in keeping close watch on developments in other countries and disseminating the results. To these ends, the following steps might be taken:

(1) by Member States individually or collectively

(a) Several countries having different types of health delivery systems should, at the invitation of WHO, undertake surveys of the principles, costs and methods of standardization of medical records, which would be submitted to a conference for discussion.

(b) Member States should encourage local work to develop guidelines for a step-by-step method of implementation of standardized elements of the medical record, beginning with patient identification, diagnosis, records of blood group, allergies and immunization status.

(2) by WHO meetings or study groups

(a) A working group should be set up to examine and discuss standardization aspects of:

(i) record content,

(ii) exchange of computer-based data between health institutions, and regional or national systems.

(b) The Regional Office should ask a small working group to develop guidelines for standardization of the medical record, having regard to:

(i) user input, so as to permit entry of essential information for direct patient care, with highest priority consideration for numerical and structured non-numerical data;

(ii) user output, so as to be able to generate record reports which will satisfy most medical users, including problem-directed, source-directed and time-based records;

(iii) computer storage, with a file structure permitting a continuing integrated computer record capable of satisfying users' input and output requirements;

(iv) the need to link medical records (The objectives of providing and using a medical record should be examined in any health care system considered. Cost assessment and cost-benefit evaluation should be vigorously applied in such studies, including estimation of the costs of medical recording systems before computer developments.);

(v) a small working group should consider and report on data base systems in operation. The information should be disseminated.

(c) Later, a working group (or Member States) should develop guidelines for progressive implementation of standardized computer records, beginning with patient identification, etc.

(d) Later, some form of working group should attempt to develop standardized medical vocabularies.

(3) A specialist team, set up by WHO, would play a very important part in producing recommendations for computer storage of records, standardized computer records and medical vocabularies.

7. Hospitals and patient care

Hospital information systems relying on fast-response on-line facilities are being developed in a number of countries. Although they are thought to have very large potential, they are complex, long-term and expensive developments. In some countries the interest in applying data processing to hospital care is at the present time confined to obtaining information about the use of resources by various units of the health care systems, which may be obtained by less complex computer facilities. While several carefully planned projects could now be said to have been partly developed successfully

or showing such promise, there have been many failures, and the Toulouse Conference (4) explored these. Even practical systems which have been introduced with apparently adequate training have failed and there is a case for ascertaining what psychological factors operate to cause non-acceptance.

It was thought that the role which WHO could play in the development of large hospital computer systems in the near future is small. However, there is more widespread interest and involvement among Member States in limited systems applied to special aspects of hospital care, and it is easy for hospital authorities to fall victim to the pressure of enthusiasts or manufacturers and introduce unsuitable or very costly systems.

The monitoring of acutely ill patients by a computer-based system has in several places been shown to be effective, and it is probable that, over the years, a rapid signal and data processing system will be necessary to advance knowledge of pathophysiology of the critically ill and to maintain the data management of such patients. But experience so far shows how little such systems, though successfully established, have been absorbed as an essential part of the care of patients; the apparently open-ended "research" orientation of such projects probably militates against this. Such systems are costly, perhaps because of this way of developing, but partly because the capacity of most computer hardware used to date for such projects is in excess of the clinical demand in numbers of patients. The costs may be high in relation to the number of patients benefiting. New systems designs, using mini-computers and more closely related to practical care and with sharply identified objectives, are needed in future developments.

The use of computers in pathological laboratories, e.g., in instrument handling and report production is, in contrast, well established, although no consensus exists that there are adequate and economic systems. It appears inevitable that their routine use in all but the smallest laboratories will come about, not least because manpower shortage may prevent any other solution of the demand placed on such services. There are obviously much more positive advantages in terms of improved quality and work through-put, faster turn-round, and better availability of information for clinical care. However, introduction seems to be outpacing evaluation, and with the multitude of possible ways of application, there is a clear need for information and assessment to be available soon to Member States. The application of computers in laboratories, even simply, begins a chain of progressive developments and it is difficult to find a point at which to stop and put forward a package system that is so much sought by many. One country recognized this and was about to issue advice based on experiences (in biochemistry only at this stage) gained so far, pointing out the considerations to be taken into account and possible, tested methods of solution.

The planning of external beam or intracavity radiation therapy has been advanced in a large number of places by off-line batch processing, and a number of centres have now developed on-line systems with visual control of the plans under test. Again, in terms of assisting the labours of those responsible, the value is indisputable, and many point to more accurate, safer, and effective treatment plans. But information and evaluation are lacking.

Other limited hospital systems (nurse allocation based on nurse-dependency of patients, menu and diet planning, etc.), may be undertaken by on-line methods from remote larger processors, possibly quite cheaply. Relatively little has yet been undertaken or is known about such work.

The participants drew attention to the need for information about work in these fields, and attached great importance to anything which could be achieved on an international scale, ideally by an information service but by international exchange until that was available, to assist progress while ensuring the minimum of duplication.

The recommendations made by the Conference were aimed mainly at securing reviews and dissemination of the state of the art in a number of computing activities. It was considered that a number of these might be undertaken by Member States if it proved impossible for WHO to start direct action relatively soon in this respect.

Recommended action by Member States or by WHO

(1) Patient monitoring. A review and critical evaluation of the state of the art of computer-based monitoring and its relevance to the provision of health care should be undertaken, preferably by an expert rather than by a conference. If this cannot be carried out by a WHO consultant, a Member State might undertake the study on an international basis as a contribution to WHO.

(2) Radiotherapy. A group of specialists should review present work using computers in radiotherapy and report on what systems, techniques and procedures are valuable and effective, and on what results have been achieved so far, especially in terms of benefits to patients; it should also evaluate alternative methods and suggest guidelines for future developments. A Member State might be asked to undertake this review, or WHO might instigate it.

(3) Laboratory systems. The methods, functions and services of computer-based systems should be reviewed and information made available to Member States.

(4) Similar studies should be planned for other hospital-based procedures: medical audit systems, appointment bookings, drug use monitoring, menu planning, either by Member States or by a WHO consultant.

For all these recommendations a substantial amount of the basic work could and should be undertaken by one or more governments of Member States. This would diminish the demand on WHO. The objectives might otherwise be partly achieved by a combination of a Member State modifying its own work programme and of intergovernmental collaboration and exchange, if this is set up.

8. Public health - preventive medicine

Perhaps because the use of computers for analysis and prediction based on data about public health derived from vital statistics and morbidity reporting is widespread in the Region, there was little discussion of this aspect, or of the part which international collaboration or WHO activity might play, or of the problems and advantages of setting up medical data banks. The place of computer-based multiphasic health screening was critically examined. It was suggested that once societies had established effective measures of sanitation, public health and immunization (the latter now considerably facilitated by computer assistance), the public call for periodic personal health surveys becomes strong. The computer is essential for the practice and analysis of such surveys. History-taking and clinical data gathering by computer and medical aids permits the large-scale activity which such survey systems demand, and frees the doctor for the specifically medical duties of examination, assessment, advice and treatment.

It was stated that the identification of unexpected disease was now but a small part of the importance of multiphasic screening, which had become established as a means of periodic assessment and control of an individual's health. Computer systems can improve surveillance and care by giving "normal values" more specific to sex, age, physiological and clinical characteristics. Although such systems had been criticized as expensive, there was now evidence of benefit justifying cost. A long-term study was described in which middle-aged men, after four years of annual health surveys, showed a significant reduction in self-rated disability and reported lost time from work, a greater proportion of them at work and a decreased use by them of medical services. There is a need for further work to determine the optimum (economic) frequency of examination and the significance of surveillance for other age-groups and for women.

Such confidence is not universal. The Twenty-fourth World Health Assembly in 1971 (7) questioned whether automated multiphasic screening of the community had been introduced prematurely, without critical evaluation and controlled trials. Specificity, sensitivity, the false positive and false negative case incidence, and the availability of adequate treatment. or the means of financing it, are all matters which have been widely debated earlier elsewhere. It might be that the importance of presently developed multiphasic computer-based systems is peculiar to those national situations where the provision of personal primary health care is minimal or extremely expensive and where public awareness of medical care has become extremely sophisticated. In a later

discussion on the priorities for medical computing, health screening systems were generally given a high priority and the spread of this opinion, perhaps surprisingly, was so diverse as not to be wholly explained by factors which might bias opinions, such as the nature of health care systems or the extent of medical computing development in different countries, or by the backgrounds of the individual experts. There is room for further very critical discussion of progress in perhaps two to three years between those who maintain a cautious outlook on multiphasic screening and those who develop it.

A more widespread interest exists in the use of public health care surveillance aimed at limited, more specific monitoring of the health of population groups with recognized or potential ("at-risk") diseases or processes requiring medical and social care: the very young and the very old, patients with congenital cardiac disease or other congenital deformities, diabetic patients, those following thyroid surgery, or using cardiac pacemakers, etc. Systems for such activities as these have been developed in many places, and range from purely statistical enumeration of the data obtained to those which actively aid the carrying out of health care by programmed activities. Once again, the call is for international distribution of information about systems and assistance in setting them up.

The Conference considered the terms "public health" and "preventive medicine" as reflecting very limited definitional concepts. Much of the matter which might be expected under this heading was incorporated in the discussion and recommendations concerning health information systems.

The Conference recommended the following action:

(1) by Member States, with the assistance of WHO consultants if necessary

Member States should conduct research and development in this field;

WHO should, upon the request of a government of a Member State, establish a team of consultants to conduct research into and development of multiphasic screening at the expense of that government, and should periodically convene consultants to discuss the results of such survey services.

(2) by WHO

The team established by WHO in collaboration with suitable specialists should prepare guidelines concerning:

(a) quality control of tests (instruments and technicians, including guidelines for training and supervision);

(b) planning, implementing and operating multiphasic programmes (facilities, equipment, systems design, organization and finance, management, personnel, operation, hardware and software);

(c) integration of such programmes into the medical, social and political community;

(d) the choice of a test battery to be included in computer-aided surveys which will show maximum sensitivity and specificity of tests in the population under surveillance, good utility and cost effectiveness (i.e., select tests for important conditions with sufficient prevalence in that community to justify the costs of testing);

(e) the mounting of long-term studies to determine optimum intervals between health surveys for particular age-groups so as to achieve maximum cost-benefits;

(f) evaluation of programmes as to their utility, operational efficiency and effect in terms of outcome for the patient.

This work might require the addition of persons to the team, to act in an advisory role, and perhaps as a training team when necessary (physician trained in preventive medicine, epidemiologist, instrumentation engineer, systems engineer and computer specialist).

With regard to these recommendations, the Conference recognized that WHO should continue to take note of the World Health Assembly (1971) view that a large-scale randomized trial, perhaps co-ordinated by WHO, should be set up to evaluate multiphasic screening before it becomes widely accepted. The Conference also drew attention to the need to give priority to computer-based health surveillance.

9. Evaluation

The shortfall in significant work evaluating the introduction of computers to medical care reflects the complexity of the undertaking and the near-absence of existing methods of measurement of care activities, in particular the costing of benefits provided. It was pointed out that much lip-service was paid to the need to be able to evaluate systems if computer developments were not to prove consuming giants, but such evaluations had not been demanded of other new technological advances; computer projects were therefore called upon to devise the methods of measurement as well as the results of such assessments. Very little had been done, and it seemed likely that evaluation itself would be very expensive. A figure of $100 000 p.a. was mentioned as the cost of mounting an evaluation of a computer-based project whose annual revenue cost was approximately $1 million. A follow-up system associated with evaluating a personal health survey for 10 000 people had cost $200 000 p.a.

The Conference considered that the gains from international activity on this subject would be the making available of the small elements of work undertaken over the Region which, aggregated and widely used, might greatly improve effectiveness; possibly the assessment of work by a WHO-nominated team might provide an element of personal detachment which could minimize any suggestion of bias.

The Conference made the following recommendations for action on the development of evaluation:

(1) Member States should be encouraged to promote and make available to WHO the results of studies on methods of measurement and evaluation techniques for hospital-based systems, and such studies themselves; WHO should distribute information and hold conferences on the subject when sufficient work appears to have been done.

It was strongly emphasized that Member States' health authorities will find themselves obliged to undertake this work for their own needs, and that it would be sensible to try to organize such work with international use in mind. WHO should assist by trying to organize concerted action and acting as a clearing house.

Member States should make available, through WHO, information about the reasons for success and failure in computer efforts.

(2) by WHO

The Regional Office should hold a conference to consider measurement and evaluation techniques for hospital-based systems where sufficient initial work appears to have been done.

10. Automated decision-support systems

The purpose of such systems is to give assistance in determining a course of action, or a "diagnosis", which will indicate a course of action, during investigations or treatment. The tools of such systems are various logical pathways, probability, Bayesian and decision theories, and relatively large medical data banks of symptoms, test and examination results, etc. It is apparent that ultimately many of the deductive processes used in medical care might be analysed and suitably resynthesized as algorithms, but early hopes for gains from this type of computer application have not materialized. It is remarkable that even where the programmes have been effectively proven and relate to fairly common problems, there has been very little growth of demand to use them.

The medical data base from which a diagnostic algorithm is derived requires symptom-characteristics from hundreds of precisely categorized patients, and the accuracy of prediction depends on the precision of the diagnostic criteria and the size of the patient sample. The compilation of the large basic data banks from which prior probabilities can be determined has yet to be done, and is a big undertaking in which there seems little interest at present.

Methods exist to minimize the limitations put on such decision algorithms by such disease features as the non-independence of symptoms, or the incomplete separation of diagnostic categories from each other (easily recognized by the proliferation of syndromes), e.g., multivariate or cluster analysis. Considerable work over a wide field of medicine is already well known (thyroid disease, bone tumours, congenital heart disease, investigation of jaundice, identification of bacteria, the acute abdomen) and much continues. There is an evident shift from seeking purely diagnostic algorithms to attempting to produce decision-aid systems to determine the "next-best step" in a mixed process of investigation and treatment. There is, of course, a steady gradation between such computer-based activities and some systems developed in the health surveillance field (e.g., a programme for supervising patients after thyroid ablation surgery, which determines follow-up practice in the light of recent findings), or even in the management field (some forms of waiting list admission scheduling). Exchange of information and the holding of regular workshops for those working in this field will greatly potentiate the scattered work. The number of interested and capable medical workers in this subject is very limited, and although large-scale results in practice are not to be expected for a long time, WHO can greatly assist by organizing international conferences among experts periodically to assess developments, and an information service could disseminate knowledge internationally about programmes under development.

Although the Bratislava Conference considered that one of the major benefits which computer technology might confer on medical practitioners in remote situations and in underdeveloped countries could be the creation of an on-line automated textbook of medicine, as a sort of simple decision aid, there are no indications that this possible system is yet reasonable. No work is known to have taken place in this field, which appears to depend both on satisfactory file retrieval systems and a logical construction of an extremely large text book. It is questionable whether anything so "simply" constructed would have advantage over the availability of good text books or could be devised for as little cost. The Conference could not advise further consideration of this idea at this time. No recommendations were made for WHO action in this subject field.

11. Health information systems

A health information system has been described as the mechanism for the collection, analysis and distribution of health statistical information required to enable planners to assess priorities and assist them in deciding how to meet particular needs, and finally to enable health administrators to measure their achievements. To some this may convey only the idea of a system set up to serve central planning, but others recognize in the term an integrated network of health information sub-systems assisting management at all levels, from the most peripheral - perhaps a medical speciality department - through hospital, community area or regional, to central requirements. Sub-systems may focus on the needs of any one or several of these. Some workers see the ultimate goal as the organizing of progressively more central, less personalized management and planning systems as automatic by-products of sub-systems designed to serve operational requirements, rather than the obtaining of centrally required data by separately required data collection systems which may be resented as intrusions on the act of providing personal health care, and hence most liable to inaccurate data provision.

There was a strong view that the introduction of computers in health care should be exploited to ensure maximum use of information potential in all data generated, to minimize duplication of data collected, and to develop adequate information systems which were considered or proved to be impractical in spite of their desirability, when based on hand-written records.

The content of a health information system might be all or parts of:

(1) indicators of the state of health of the population:

(a) morbidity data from hospitals, general practitioners, school physicians, etc.;

(b) mortality data;

(c) information on preventive measures: immunization, etc., surveillance of those at high risk, cancer control;

(2) use of the health services:

hospitals, ambulatory care, laboratory facilities, etc.; information on supplies, including prices and consumption at all levels, use of drugs;

(3) information on available resources:

medical personnel of all kinds; buildings, equipment, finance.

Traditional health systems are slow-moving and not capable of quick action. Much information is lost by presentation in summarized form; most important, the traditional health statistical systems lack integration, and linkage with related information is seldom possible.

A health information system might best and first be based on a register covering all people in an area or region to which hospital discharge summaries, birth, marriage and death certificates, notifications of persons at risk, notification of cancer cases, etc., could be linked. Of decisive importance in establishing a data bank of this type is some kind of personal identification number, although computer-based techniques exist and have been used which overcome the problem, with excellent matching, if such a number cannot be used.

Success with integrated hospital or regional information systems has been very limited; tremendous sums of money have sometimes been lost in experiments that failed. There is a need first for the development of models of information systems, then controlled experiments whose progress should be widely reported to reduce duplication. In spite of the differences in health systems as between Member States, much could be gained from international information. The WHO European Region is to hold a Conference in 1973 on National Health Information Systems.

The several failures and many isolated current attempts in this field might reflect an unwillingness on the part of doctors and health care professionals to look outside medicine for management information systems; there seem at least to be some parallel systems, such as hotel reservation systems, which resemble appointments and waiting list systems and which might be transplanted more easily from industry rather than developed anew. However, the Conference recognized that industrial information systems are rarely integrated, and that the special distinction of health care management, in which the equivalent of the industrial "item" is an individual patient, made hope for help from this direction slender. What is clear is that an effective information system calls for a precise description by managers at every level of what they require, and intimate collaboration, from the beginning, by systems designers.

All aspects of computer-based records create attitudes of suspicion regarding new infringements of confidentiality, even though for protection of specific records there is probably greater safety in a computer file than a case folder and it is possible to provide even greater inaccessibility by several techniques. What is more reasonably feared is the ability to search large files of records swiftly or to link separately compiled records to the disadvantage of an individual. Anxiety is greatest where medical information is linked with non-medical data. Most health systems are being designed so that data which may have been first acquired for the management of individual patients' care (a level where identification is essential) are automatically depersonalized if they are to be used for management purposes. Often identification and medical data are held in physically separated files linked only by complex coding.

The argument has been advanced that to reassure the public, data files should be used only for the purposes which were expressed or implicit to the patient when the data were gathered. This would be of great help at the present time.

The major problem arises in the use of medical records for research, when this is of a kind which makes identity or contact with the patient by someone other than the originator of the data essential. There is no easy solution to the problem, but one possibility would be the appointment of a "licensing authority", e.g., a person or group of persons of acknowledged integrity, who would be responsible for considering requests for access to identifiable individual records where these are not covered by appropriate rules.

The computer-based data bank is a new concept that differs significantly from anything of which we have previous experience, and much still needs to be done to establish controls that will be acceptable to the general public.

WHO might perhaps help to combat unreasonable opposition to the use and existence of medical computer files by emphasizing the important role doctors are playing in computer projects.

The Conference recommended that the following action should be taken:

(1) by Member States

Members should collaborate in outlining to WHO their concept of the requirements of a health information system, including descriptions of its extent, and should assist WHO work in this field by providing a full description of studies and work undertaken.

(2) by WHO

In view of the potential of the recent Regional Office decision to collect, inter alia, data about health information systems, and the 1973 Conference on Health Information Systems organized by the Regional Office for Europe, WHO should pursue activities in this field, possibly through a working group,

(a) to define the basic elements which should form a health information system capable of satisfying medical and administrative needs;

(b) to identify the likely benefits and cost of such systems;

(c) subsequently to develop standardized medical vocabularies.

Further, the Organization should:

(a) analyse health delivery services and make available guidelines or outline designs of health information systems;

(b) distribute information and guidelines developed and provided by Member States on the sensitive subject of computerized data confidentiality, and in particular to contest unreasonable opposition to the existence and use of medical computer files, by emphasizing the major role played by doctors in many such computer developments.

12. Research in medicine and public health

The different aspects of association between computers and research may be recognized. In one, the computer is mainly a tool for performance or analysis of the research and relatively little or no special development of hardware or software is required. In the other, developments of computer technology are demanded to pursue the research, and these developments may themselves be considerable undertakings and represent substantial contributions to computing science. Picture processing is an example of this.

There is a large miscellaneous group of applications arising from the calculating and data-handling powers of computers. These are the subjects of much national and academic statistical analysis. Epidemiological studies employ extensive model building and WHO has itself already initiated much work in this field. The experience of WHO Headquarters might be made available to Member States.

The application of computing to pattern recognition covers a broad front. The oldest type of pattern recognition in medical computing is the diagnostic process; although much work is going on throughout the world it is still too early to form judgements and advice for WHO action. The matter was discussed briefly and separately during the Conference.

The analysis of waveforms, particularly the ECG, is advancing fairly rapidly, and the role of WHO here seems again to be one of watching developments and exploring areas in which the computer can help to compensate for shortages of fully trained medical personnel.

Picture processing is still in a state of development. Many of the major computer programming problems may have been solved, but the implementation of practical systems of reading the pictures and extracting the necessary information for computer processing involves very difficult technical problems which overshadow the purely computer aspects. For example, the determination of karyotypes can now be done by computer as effectively as by human beings but the mechanical and electronic equipment required, such as mechanized microscopes and high-quality-image tubes is still a long way from quantity production. It is also a continuing possibility in cytological work that biochemical methods may be developed which would supersede computer processing.

Finally, there are many problems of file handling and linking which arise and are peculiar to the use of computer-based medical records if these are to be developed on a large scale. Work is in progress throughout the world and WHO will need to keep abreast of this.

The Conference recommended that WHO should disseminate information on the subject of computing in medical research by briefing consultants to undertake specific reviews of matters at present the subject of research, to indicate those which are likely, less likely or unlikely to be of practical use for service implementation, including consideration of the hardware requirements, programming and costs.

13. Priorities and resources

It is inevitable that a Conference composed of participants who themselves have special experience or interest in data processing should readily identify a great deal of work which can advantageously be promoted or carried out at international level, and that such a group may find it difficult to constrain their recommendations in the light of the other demands made of an international health care programme. The implication of almost all the proposals for medical computing are expensive, and as has been seen in several Member States, the expenditure needed to carry out even limited experiments may seem frightening when set against costs of other parts of the health programme. Even though the benefits may be proportionately greater, their certainty is not yet assured. Informal discussions during the meeting illustrated that to effect all that was suggested might involve costs in excess of those for other established WHO programmes.

One of the strongest reasons underlying many of the recommendations was the conviction that the large costs involved in the development of medical computing should, wherever possible, be spent for the good of as many as possible; that isolated and independent developments multiplied the cost not only by possibly avoidable duplication, but by ignorance of the success and failures, and more importantly, of the reasons for these, from one country to another. The viewpoint was also apparent that the benefits which could flow from progress may be so great that precisely those who can least afford experiment are among the countries for whom successful computing systems might achieve most, and that they should not be excluded from knowledge of and participation in this rapidly developing field.

It was recognized, therefore, that in spite of the importance of the recommendations made for every topic, it was unreasonable to expect that all could be carried out by WHO with the resources available to it.

First it might be possible to make further resources available to WHO

(a) by donation of additional funds to WHO from individual Member States, specifically earmarked for medical computing development;

(b) by a Member State being prepared to undertake, at its own expense, work flowing from a recommendation, at the request of, and for, WHO (which might, as a secondary effect, provide benefit to that country);

(c) by a Member State modifying some existing or planned work in its own programme so that it would assume international significance.

The last two means are not mutually exclusive, and were thought to be the most practical.

In order to maintain momentum, it was therefore suggested by a number of participants that international collaboration should be set up, if possible, to assist progress in this manner. A set of proposals (Annex III) was prepared which participants could put before the responsible ministries in their respective countries.

The determination of priorities among tasks must rest on a number of considerations, not merely on the availability of money, and the problems of determination are basically the same, whether they are in relation to an international (WHO) programme or to that of an individual country. There are two contrasting approaches to decision-making. One may assemble all the tasks which it is agreed should be attempted, without regard at first to the resources which will be allocated to the whole enterprise, in a priority order based on a set of criteria. This done, a line is drawn through the list at a level where resources will be exhausted by the tasks above the line, and will fail to cover those below. Or one may ask how much will be allocated to a given group of tasks. The priority list is then compiled again by a set of criteria, to the limit of the allocation.

In practice, neither method is usually applied exclusively, and whichever the starting point, the other method is soon applied, even if only implicitly. Each contributes to modification of the original list and, provided strongly divergent motivations do not operate among assessors, and that the criteria for priority are agreed, very consistent rating may be achieved by some form of voting grades of priority using a small value-scale. This was shown by voting used at the Conference, in spite of the differing health systems in Member States. Among the criteria of significance were:

(1) Feasibility of international or WHO action, in terms of money, personnel and the existing situation (with regard to development of specific computer applications, this relates to technical and operational feasibility, representing the computer and user environmental conditions).

(2) Urgency, particularly in the sense of "if action is not taken soon, it might not be worth taking".

(3) Speed and effectiveness of any WHO or international action.

(4) Relationship of suggested activity to other WHO priorities, e.g., cardiovascular disease programme, or studies of national health information systems.

(5) The nature of the commitment engendered by the recommendations, i.e., whether it calls for a once-only or a continuing obligation.

(6) The possible useful impact of the recommended task on the main areas of health care in which it is thought computers might be of greatest effect: allocation of resources, best use of allocated resources, and improvement of the standard of direct care to the individual.

(7) "Synergy", taken to mean that one recommended activity is so closely related to another that its priority should be raised, because the sum effectiveness of the two will be greater than that of the separated parts.

Many of the recommendations lean heavily on central action by WHO and therefore depend upon the ability to set up a team. The Conference regarded the setting up of a WHO regional team as a matter of high priority.

Within specific areas of medical computing, highest priority for co-ordinated action was accorded to:

(a) medical records,
(b) health information systems,
(c) automated multiphasic health surveillance systems,
(d) clinical laboratory systems,

and lower priority to:

(a) patient monitoring systems,
(b) radiation treatment planning,
(c) questions of confidentiality, and other ethical and legal problems associated with medical computing.

The Conference recognized that some of its recommendations might be more effectively performed if they were related to similar activities in other parts of the world, but did not consider that itemizing those which might be undertaken jointly with other regional offices or by WHO Headquarters lay within its terms of reference.

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AGENDA

1. Opening
2. Scope and purpose
3. Education and training
4. Information and advice
5. Medical records
6. (a) Hospitals and health care
   (b) Evaluation
7. (a) Public health - preventive medicine
   (b) Automated decision support
8. Health information systems and related issues
9. Research in medicine and public health
10. Provision and allocation of resources
11. Technical visit[1]
12. Summary and conclusions

[1] Visit to the European Communities' Kirchberg computer facility for a demonstration of the nuclear sciences information retrieval system

LIST OF WORKING PAPERS

EURO CSO1(2)/5	Education and training - Dr J.C. Pagès
EURO CSO1(2)/6	Information and advice - Dr L.G. Sudarikov
EURO CSO1(2)/7	Automated medical records - Dr P. Hall
EURO CSO1(2)/8	Hospitals and patient care - Professor P.L. Reichertz
EURO CSO1(2)/9	Automated decision-support systems - Dr M.F. Collen
EURO CSO1(2)/10	Computer-aided health surveys - Dr M.F. Collen
EURO CSO1(2)/11	Health information systems: general problems - Dr J. Mosbech
EURO CSO1(2)/12	Medical research computing - Dr C.C. Spicer

PROPOSALS MADE BY PARTICIPANTS FOR INTERGOVERNMENTAL COLLABORATION IN THE FIELD OF MEDICAL COMPUTING

1. Interested governments in the WHO European Region should establish arrangements for regular meetings.

   1.1 The meetings should be attended by officials at a high managerial level responsible for the co-ordination and development of medical computing.

   1.2 The Regional Office should be invited to participate in the meetings.

2. The purpose of the meetings should be:

   2.1 to review progress in medical computing in the participating countries, especially in those activities delineated by the 1972 European Conference on Medical Computing;

   2.2 to evolve and agree on further work that would contribute to the implementation of these recommendations;

   2.3 to discuss the advice on medical computing needs, benefits and priorities that might be offered to Chief Medical Officers in time for each meeting of the Regional Committee for Europe.

3. The meetings should be held annually, normally in early summer.

4. Each government in turn should act as convener.

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