Health and Medical Informatics:

Technical Paper

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1. Introduction

The goal of the information management function is to obtain, manage, and use information to improve the health care and medical services' performance, governance, and management and support process. Delivering health care to the population is a complex endeavour that is highly dependant on information. Hospitals rely on information about the science of care, individual patients, care provided, results of care, as well as its performance to provide, coordinate and integrate services. Like human, material and financial resources, information is a resource that must be managed effectively by the health care managers and leaders.

In this paper, the basic assumption is that information technology has no value unless the information component in it is the prime target. Information technology is a tool to help the management of information. Health information management has become one of the essential elements of the national health care system. The growing interest in the subject and the increase in allocation of funds for its development have lead to its institutionalisation and recognition by top management and health workers. The growth of health information management systems is based on a number of assumptions (1):

- Health care will increasingly be an **information-driven service**;
- Information is a **major resource** which is crucial to the health of individual patients, the population in general, and to the success of the organization;
- Health information systems should be **viewed on a continuum**, beginning with patient-specific data (clinical), moving to aggregated data (performance, utilization, etc.) to knowledge-based data (planning and decision support), to comparative, community data (policy development);
- The **quality** of data and its transformation into information are basic to the efficiency and effectiveness of all information systems. Emphasis should, therefore, be placed on information that has value in decision-making, evaluation, planning, and policy development;

The integration and assimilation of technology into the everyday life of health managers and health professionals will inevitably become an increasing reality. Therefore, the purpose of this paper will be on **where and how information technology can contribute to the improvement of health care.** In other words what is and what for is health and medical informatics?

The terms *'medical informatics*' and *'health informatics*' have been variously defined, but can be best understood as the understanding, skills and tools that enable the sharing and use of information to deliver healthcare and promote health. 'Health informatics' is now tending to replace the previously commoner term 'medical informatics', reflecting a widespread concern to define an information agenda for health services which recognizes the role of citizens as agents in their own care, as well as the major information-handling roles of the non-medical healthcare professions. Health informatics is thus an essential and pervasive element in all health care activities. It is also the name of an academic discipline developed and pursued over the past decades by a world-wide scientific community engaged in advancing and teaching knowledge about the application of information and communication technologies to healthcare - the place where health, information and computer sciences, psychology, epidemiology and engineering intersect. Twenty years ago medical informatics was seen largely in terms of the computerization of healthcare. Today, with computers much more a part of routine daily life, **there is a tendency to reduce the specific emphasis on computers and technology in health informatics, and to stress the meanings of information** in the

everyday work of healthcare professionals, in communication, shared knowledge and decision-making, and in the complex social and functional needs of healthcare organizations and services.

Medical Informatics addresses profound information needs in medicine. Clinicians face an ever-growing plethora of diagnostic and therapeutic options and volumes of data relevant to patients with critical or chronic conditions. Health professional students must assimilate volumes of factual, conceptual and procedural knowledge that defy traditional educational media. Biomedical researchers in the quest to expand current medical knowledge swim in a sea of millions of pages of biomedical literature published annually, making communication of new findings among colleagues difficult and dissemination to health care professionals impossible.

Added to these are the growing needs of health service and public health researchers to measure and improve the quality of health care and health care systems. Evaluating the efficacy, efficiency and cost of clinical care requires novel approaches to data acquisition and analysis. Moreover, medical informatics applications, which are intended to improve the quality, efficiency and cost of care, will also be subject to rigorous evaluation.

Computers and information technology offer the promise of capturing, organizing and presenting medical information in a form that will make it useful to all endeavours in health care. In the health care setting, **this means not merely recording, storing and reporting data, but bridging the gap between the data captured and the knowledge needed by the health care professional**. Computer science and information technology have advanced in parallel with the information needs of modern health care. Advances in high performance computing, and communication, image processing, database technology, computer based decision-support and computer-aided instruction have proceeded at breakneck speed.

2. Definition of medical informatics

Simplistic definition: *Computer applications in medical care*.

Complex definition: *It is the field of study concerned with the broad range of issues in the management and use of biomedical information, including medical computing and the study of the nature of medical information itself*. (2)

A more complicated definition: Biomedical Informatics is an emerging discipline that has been defined as *the study, invention, and implementation of structures and algorithms to improve communication, understanding and management of medical information. The end objective of biomedical informatics is the coalescing of data, knowledge, and the tools necessary to apply that data and knowledge in the decision-making process, at the time and place that a decision needs to be made. The focus on the structures and algorithms necessary to manipulate the information separates Biomedical Informatics from other medical disciplines where information content is the focus.* (3)

It is defined also as the "*science underlying the acquisition, maintenance, retrieval, and application of biomedical knowledge and information to improve patient care, education, research and administration*." (4)

Health informatics was defined as *"an umbrella term used to encompass the rapidly evolving discipline of using computing, networking and communications - methodology and technology - to support the health related fields, such as medicine, nursing, pharmacy and dentistry".* This definition covers a very large domain which includes clinical and administrative messaging, reference retrieval, operation and management of health services, patient information, health education and promotion, epidemiological surveillance, health status monitoring, clinical decision support, image and signal analysis, modelling and telemedicine. (5)

3. Potential benefits of informatics applications

Without exception, all health care organizations use information technology in one form or the other. Discussion has been for a long time as to what are the direct and indirect benefits of information technology in medical and health care. The return on investment (ROI) the organization stands to gain is a factor that managers look for when they introduce these technologies to their organizations. The ability to maximize information technology benefits and the associated ROI is becoming an integral part of the executive management information technology skill set. Three categories of potential benefits can be identified by use of computers and electronic data processing in the health care sector; they are:

1. **Quantitative benefits**: These are financial benefits that are clearly measurable and are attributable to the use of a particular technology. For example the use of electronic data interchange technology to transmit surveillance data in real time mode or to electronically submit medical claims which results in time saving and labour cost;
2. **Qualitative benefits**: These are directly and indirectly attributed to the technology but are more difficult to quantify. These benefits are measured only in terms of the impact of technology on the performance of systems and their efficiency. Accurate data, fast transfer of data, wider accessibility and linking of data elements are benefits that are not easily quantified;
3. **Strategic benefits**: These offer substantial benefits to the health care organizations, but at some future date. Data collection and analysis brings immediate benefit to the organization, but in the long term this data constitutes the basis for medical and health research and strategic planning. Electronic medical records do not only serve the current needs of health care, but also on the long term.

4. Medical data in computers

Information can be accessed in different forms and by different types of media and carriers. The different types of carriers that transport information are:

1. **Integers**: a **discrete number** (e.g., the number of cases in a population: this population can be human or a sample of specimen or age in years, months or number of hospitals or health units);
2. **Reals**: a measured variable (e.g., a temperature or a blood pressure);
3. **Codes**: an observation (e.g., pain or a swelling or codes representing diseases or drugs);
4. **Text: natural language** (e.g., text in the case reporting giving explanation of things or annotation in the form of events, description, etc.) and

5. **Graphics and maps** in the form of Geographic Information Systems, diagrams, x-Ray images, charts.

A most important issue related to the recording of medical data in a computer and its presentation is the **completeness**, **reliability** and **precision** of the different types of data. These factors together make the quality of data regardless of its type:

1. **Completeness**. Incomplete data may result in uncertainty. In case reporting it is not always clear whether data are missing or are absent because they were considered to be irrelevant, or were just not documented in the data collection sheet;
2. **Accuracy** is the ability to perform a task without making mistakes or errors, or it is the degree of conformity of a measure to a certain standard or a true value. The former meaning can be characterized as correctness; the second one can be characterized as conformity or exactness. **Correctness** is a measure of the error rate of the data. Errors are first made during data collection, either in observations or in measurements. The observed value also has a deviation due to reading or measuring errors. We have here to distinguish between the systematic and the statistical errors. **Conformity** of data pertains to following standards or classification systems for data recording. When classification and coding systems are used to document cases, we need to follow the rules and use the definitions of the classification system to select a proper code;
3. **Precision** deals with the degree of refinement or granularity by which a measurement is expressed, such as the number of decimal places. A body weight expressed as 89.12 kg expresses a higher precision than a weight expressed as 89.1 kg. It is misleading to specify a value with a higher precision than the accuracy with which the value is obtained. It is equally misleading that the weight of an adult for example should be expressed with two decimals if this precision does not bear any meaning;
4. **Coding.** A factor related to the quality of data is coding. In **coding** data, the user should first interpret the data and then assign a code. Interpretation errors are inherent to coding. On the one hand, the coding of data limits the way of expressing oneself, but on the other hand, it enforces **standardization of terminology**, which is extremely important if the data is to be used by people other than data collector, which is the case in all health indicators data; and
5. **Free text.** Free text (or **natural language**) gives the user the greatest liberty to express details. However, free text is essentially non-standardized, which makes computer processing difficult. Free text can be seen as the personal interpretation of observed facts. If some other user needs these free text data, he or she will read the text, interpret it, and mentally reconstruct the medical object described from the interpretation. Therefore, semantically, free text has insufficient structure and is open to multiple interpretations. Such interpretation errors are unlikely to be reduced by computers. Free text in health indicators maybe used to describe the indicators themselves, the way they were calculated and the source of information.

In conclusion, several important rules can be phrased, based on the quality factors that have been emphasized above, to enable better recording of medical data in computers:

- Data should be acquired as close to the source of the data as possible;
- Data should be recorded by obeying strict rules of standardization and coding;

- The original data should be stored, and if possible, human interpretations should be stored only if the raw data they are based on are also stored;
- Coding of data should be done only if there is no other way to present the data, and it should preferably be done by the person making the observation;
- For all data entered, there should preferably be an on-line **feedback** to the user to signal possible deviations from what should be expected;
- Persons who enter the data should ideally benefit from this data entry, either because they will use the data later on or because it will improve the quality of their work; and
- Authentication of data (adding the coder's name and signature) and time stamping of data improves the data quality.

The above relates to the soft part of medical informatics or to the content of the system. Using computers or any other form of medical informatics requires strict discipline as to how to, what for, by when and who is to use this information.

5. Importance of informatics to the essential physician's roles

The argument that medical informatics should be a central feature of the medical undergraduate curriculum rests on the intimate relationship of information management to the five essential roles envisaged for the future physicians. For each one of these roles the medical informatics learning needs could be stated into learning objectives. These roles are namely:

(a) ***Informatics learning needs for " the life long learner role".*** To fulfil this role the graduate should be able to demonstrate knowledge of information resources and tools available to support life-long learning. The knowledge includes the awareness of these resources, their content and the information need they can address. The skills, which are needed for this role, include the ability to retrieve information as well as filtering and evaluating it. While the required attitudes will include developing appropriate information habits;

(b) ***Informatics learning needs for "the clinician role".*** To fulfil this role the graduate should be able to use appropriate and available information technology to acquire and analyse patient information leading to proper clinical decision-making. The range of informatics skills which are required for this role include the ability to store and retrieve patient information, the analysis of such information including laboratory information and using any supportive facilities to this end. The necessary attitudes, which relate to this role, include attention to confidentiality of patient information and its security in the electronic medium;

(c) ***Informatics learning needs for "the educator/communicator role"***. Medical and health practitioners need effective education/communication skills in the context of relating to students, peers, patients and the public at large. This role will be facilitated by skills enabling utilization of the information technology and its potentials for making effective communication messages and presentations. It also includes the ability to access and utilize relevant information resources on the Internet, on CD-ROM or any other electronic format;

(d) ***Informatics learning needs for "the Manager role".*** To fulfil this role the graduate should be able to collect and analyse information about service clients, the work done and the system functions, which when put together make up the ingredients of a management information system. The relevant informatics skills for this role include ability to use information technology for collection, storage, retrieval and analysis of service information. The learning may as well include introduction in relevant course to certain packages used for the management of resources, supplies, personnel and surveillance information;

(e) ***Informatics learning needs for "The researcher role".*** Throughout their career medical graduates will be involved in the consumption of research products and in many instances conducting their own research. Research includes traditional biomedical research in the laboratory, clinical research, population-based and health system research. The relevant informatics skills needed for this role include the knowledge of literature sources and how to access it, the use of computers in data collection and analysis and how to disseminate its results.

6. The Need for Health and Medical Informatics Education

Throughout the world, health care professionals often lack knowledge of the possibilities and limitations of systematically processing data, information and knowledge and of the resulting impact on quality decision-making. They are often asked to use information technologies of which they have limited appreciation, in order to enhance their practices through better use of information resources. However, for systematically processing data, information and knowledge in medicine and in health care, health care professionals who are well-trained in medical informatics or health informatics are needed (6). It has been recognized that it will only be through improved education of health care professionals and through an increase in the number of well-trained workers in health and medical informatics that this lack of knowledge and associated skills can begin to be reversed.

Health and medical informatics education is of particular importance at the beginning of the 21st century for the following reasons (7):

1. Progress in information processing and information and communication technology is changing our societies;
2. The amount of health and medical knowledge is increasing at such a phenomenal rate that we cannot hope to keep up with it, or store, organise and retrieve existing and new knowledge in a timely fashion without using a new information processing methodology and information technologies;
3. There are significant economic benefits to be obtained from the use of information and communication technology to support medicine and health care;
4. Similarly the quality of health care is enhanced by the systematic application of information processing and information and communication technology;
5. It is expected, that these developments will continue, probably at least at the same pace as can be observed today;
6. Health care professionals who are well-educated in health or medical informatics are needed to systematically process information in medicine and in health care, and for the appropriate and responsible application of information and communication technology;
7. Through an increase in scope and the provision of high quality education in the field of health and medical informatics, well-educated health care professionals world-wide are expected to raise the quality and efficiency of health care.

7. Areas of application of medical informatics

7.1. Management

This is concerned with support to management activities in health care and, as such, it ranges from the management of an activity, such as an immunisation or an awareness campaign, to the management of a national programme (e.g. disease control), to the management of a health care institution (e.g. a hospital or a laboratory) or the management of the entire national health services.

'Management' is meant to refer to the cyclical process of problem analysis, planning, programming, budgeting, implementation and monitoring, evaluation, and re-planning. Thus, it is not restricted to, but includes, logistics, administrative and financial management. For example, whereas it includes the support to the monitoring of expenditure against approved budgets, it must also support the managerial necessity of relating resources (financial, human) to the various aspects of the health services and programmes.

Whereas there are numerous examples of informatics and telematics support to logistics, administrative and financial management, there are no fully developed systems supporting management as broadly defined above.

7.2. Epidemiological Surveillance

Disease surveillance involves collection of ongoing routine data to examine the extent of disease, to follow trends, and to detect changes in disease occurrences. Epidemiological surveillance is essentially the study of the patterns of distribution and the trends of diseases and related health care measures, by geographical areas, age groups, communities, etc., so as to establish priorities and optimise health care measures through monitoring and evaluation. This requires the collection and analysis of varied and relatively large amounts of data, from and about the locations where diseases and related health problems occur and from where patients present themselves, typically in urban and rural health centres and hospitals.

Informatics and telematics support to health statistics and epidemiology are perhaps the earliest and thus more popular applications of computing in developing countries. It is also an application area that calls for the most improvement. Arguably, certain traditional routine data collection practices could be replaced by more economic computer-supported sampling techniques. Also, relatively simple computer support to the patient "admissions, discharge and transfer" function in a hospital, and the equivalent in a health centre, could eliminate or improve on the accuracy, time and cost of manually maintaining statistical forms - since such statistics could be computer extracted from the application. Furthermore, better or more utilisation of obtainable satellite-based remote sensing data could provide the essential intelligence sought for surveillance.

The developments in informatics, and particularly telematics, stress the need for a major rethinking of the traditional methods employed for surveillance, early warning and sentinel systems, especially on communicable diseases.

7.3. Computer-based medical record

The increasing demand for well-structured and accessible patient data, in combination with developments in computer science sparked great interest in the development of an electronic patient record. Computers have the potential to improve legibility, accessibility, and structure, but these pose heavy demands on data collection. The computer-based medical record has a number of advantages, which made it an essential requirement for health care; these include:

1) Simultaneous access to its contents from multiple locations. Consultants, physicians and nurses located in separate buildings or in remote locations (countries or cities) can have access at the same time to the patient record to give a unified view of what is in it;
2) Legibility of content as data is machine coded or typewritten. There is no room to make a mistake based on data misrepresentation;
3) Variety of views on data. As data is electronically stored in structured manner, it can be presented in different formats with built-it relations;
4) Support of structured data entry as data elements are well-defined. Many of the data elements can be tagged as elementary or essential, which means the operator, has to enter the data before moving to a new data field. This will ensure that the record is complete and useable in the future;
5) Decision support. A complete and accurate medical record will allow the physician to make decisions based on data available on the record. The ability to link data elements and generate new information based on inferences can help in decision making in clinical trials and medical care;
6) Support of other data analysis. Medical research, epidemiological surveillance and disease trend analysis can be based on medical records. This type of analysis is not patient based, as the need here is to generate information based on extraction of data contents from a set of records. This may help in showing the relation between geographic location and a certain disease or disease and age group, etc.;
7) Electronic data exchange and sharing care support. Two hospitals will be easily able to share the content of a medical record electronically without a need to move files between locations. Parts of a record can be copied to other locations based on definition of needs and access rights.

The above advantages maybe even multiplied if a multimedia medical record is made available using the storage capabilities of new computer systems. A medical record may include X-Ray images, charts, sound recordings, diagrams and pathology reports. These do not only have clinical value, but are also invaluable for educational purposes.

In order for electronic medical record to accomplish its clinical, legal, and administrative requirements, an information infrastructure must be in place to support the various data capture, storage, processing, communication, security, and presentation functions.

Confidentiality of patient's information and its security in the electronic medical record pose a challenge for the medical/health, the informatics and legal communities at once. The design of the record and its application should from the start consider confidentiality as an essential element for future success. The legal framework and the technological environment work together to reach high quality medical record application, which might be accepted by both the medical/health community and the public at large.

7.4. Access to Literature and Information Services

Many libraries in developing countries are prime victims of the economic and hard currency problems. Many health and medical libraries in universities and health care institutions have had to dramatically reduce their acquisitions of journals and publications of foreign medical societies. The uses of CD-ROM's, whereby foreign libraries' holdings are listed, largely alleviate the search problem, but the acquisition problem remains.

The gravity of the paucity of scientific literature was the main motivation of the international scientific community to collaborate and seek affordable means of linking scientists in developing countries to international networks to access the available information and literature services. The health sector is a major beneficiary of this collaboration.

Health and biomedical literature is presented in a number of electronic media, which facilitates access to this literature, by the health care community; these include:

1) ***Health and biomedical information on CD-ROM***. The most cost-effective electronic publishing medium of health literature has been the CD-ROM. MEDLINE on CD-ROM and many other bibliographic databases have reached the most remote health care units in most countries;
2) ***Electronic journals***. Online abstracts or those available on CD-ROM have become inadequate for many medical professionals, as they need the full text of articles and research papers. In response to this need, many publishers of medical journals have either moved to electronic publishing or have published their journals in two formats (printed and electronic). Many of these journals are available free of charge on the Internet or on CD-ROM;
3) ***The Internet***. Many health care organizations and publishers have started to use the Internet as a vehicle to publish their products and services. These products may include textbooks, manuals, video clips, articles, frequently asked questions, drug information, etc. A major issue is still the quality of biomedical information on the Internet;
4) ***Electronic Mail Systems and Discussion and News Groups***. E-mail was the main initial driving purpose of telecommunication links, and has been and is being extensively used to directly link individuals and institutions of similar professional interests or engaged in joint activities and projects. The same links that enable e-mail also enable the establishment of electronic bulletin boards, discussion groups and even teleconferencing. E-mail of text messages is in fact the least costly computer application because messages are primarily "stored and forwarded", that is no time-consuming processing is involved. The past five years have witnessed an exponential growth in email in and between developing countries and internationally, particularly over the Internet and over networks of a simpler technology bridging onto the Internet. Actual experience has shown that the installation of a networking and an email facility in one site vigorously triggers the enthusiasm for more and more national and international links, even via simple relatively cheap radio-links or semi-reliable local telephone lines. E-mail services are not to be confused with, and are only one aspect of, the full range of multi-media services on the Internet.

   Specific examples of Internet use by the health and medical community include:
   - Medical training and continuous education;
   - Medical information access;

- Patient care and support;
- Remote diagnosis and consulting;
- Emergency/ epidemic support;
- Tele-working for the disabled;
- Preventative care education and preventive health;
- Electronic publishing of full-text of health and biomedical literature.

7.5. Knowledge-based Services

An application area that is, relatively speaking, recent but will expand with the spread of informatics and telematics support is the access to and use of knowledge-based systems - also known as Expert Systems and Decision Support Systems. These are systems that provide expert advice on medico-scientific issues. For example, given a patient's coordinates and symptoms, it could provide diagnostic support, suggest additional tests or propose a treatment. Starting in the mid-1970, a growing number of knowledge-based systems have been developed in the health sciences. Such systems often include a combination of:

a) Literature data (from journals articles and textbooks); and,
b) Factual data (e.g. guided by experts and derived from well-documented patient cases).

Appropriate knowledge-based information is acquired, assembled and transmitted to users at the appropriate time. Knowledge-based information management consists of systems, resources and services to:

1) Help health care professionals acquire and maintain the knowledge and skills they need to care for patients;
2) Support clinical and management decision making;
3) Support performance improvement;
4) Satisfy research-related needs; and
5) Educate patients and families.

Large knowledge-based systems under active development have the potential for becoming national and international responsibilities of medical knowledge. The work of the National Library of Medicine in development of the Unified Medical Language System (UMLS) is an example. UMLS develops and distributes multi-purpose, electronic "Knowledge Sources" and associated lexical programs. System developers can use the UMLS products to enhance their applications -- in systems focused on patient data, digital libraries, web and bibliographic retrieval, natural language processing, and decision support. Researchers find the UMLS products useful in investigating knowledge representation and retrieval questions. (8)

Expert or decision-support systems (older name of knowledge-based systems) have some shortcomings, as a clinician cannot convey his or her complete understanding of a patient case to a computer programme. The computer programme in most cases is not capable of assimilating all data input to it. The training requirements for the system and the operators are very demanding and are never ending. This training or lack of it will influence the clinical decisions made by the physician. A few knowledge-based systems are in use, on an experimental basis, in many developing countries including some that have been developed by institutions and groups in the developing countries themselves.

A few main issues, which are not unique to developing countries, remain to be resolved. For example, the assurance that the content of the knowledge base has been vetted by a recognised authority - who and how; the validity of the knowledge base when it is transported from one setting to another; and the lack of legislation concerning the respective responsibilities of the developers, users and intended beneficiaries of such systems. Nevertheless, knowledge-based systems are and can be valuable sources of expertise and knowledge, especially as they double up as educational and training tools. These are particularly useful to remotely located physicians and other health workers, depending on the availability and types of telecommunications services.

7.6. Geographic Information Systems

Geographic Information System (GIS) is an organized collection of computer hardware and software, geographic and tabular data and people and knowledge designed to capture, store, manipulate, update, analyse, and display spatial data. GIS have become an essential part of health information systems as they provide visual presentation of statistical data with a clear link to geographic locations. As a system, GIS comprises five major parts to make it a functional system. They are: hardware, software, data, procedures and people. The content of the GIS is made of the spatial database and the attributes. The benefits of the GIS include relating spatial and attribute data, provision of cartographic display on demand, ability for application customisation, ability of data entry, data processing, data integration, availability of database management features, visual database analysis and visual reporting capabilities on the screen or in printed format.

7.7. e-Health and Telemedicine

Telemedicine is the "*use of information technology to deliver medical services and information from one location to another"*. It is "*medicine at distance"*. It uses electronic signals to transfer medical data (i.e. high-resolution photographs, radiological images, sounds, patients' records, and videoconferencing) from one site to another. It has been defined as "*The practice of medical care using interactive audio, visual and data communications; this includes medical care delivery, consultation, diagnosis and treatment, as well as education and the transfer of medical data".* The term “education” covers both the education of the patient and the “continuing education” of the health care staff. Four essential components make the e-health:

1) Medical knowledge that lends itself to being stored in computer files (digital format);
2) People who are willing to share, apply and use this knowledge;
3) Data processing equipment to record, store and process this data;
4) Telecommunication facilities to transfer (exchange) this data electronically between remote locations.

Telemedicine has become as one of the most familiar applications of medical informatics. It makes full use of the computing and telecommunications features of this technology. Telemedicine has many serious issues embedded in its applications. Some of these issues are technological; others are managerial and legal.

8. Medical informatics in the EMR: Situation Analysis

1. Introduction

A survey was conducted during May 2001 to assess the health and medical informatics situation in Ministries of Health in EMR Member States. A structured questionnaire consisting of 26 questions was distributed to 20 countries in the Region. The questionnaire was divided into three sets of questions as shown later. 18 countries (90%) responded by completing the questionnaire.

2. Analysis of the results of the first set of questions:

The first set is composed of 11 questions aiming at assessing the status and infrastructure of information technology in Ministries of Health in the Region. Three options were provided for each question to indicate if the function/service is available, being panned or not available. The analysis as follows:

1. **Functional National Health Information System**. Eight countries (44%) said that they have a functional national health information system, while ten (65%) said it is planned. No information is available on the state of development of these systems. The above shows that majority of member states have realized the importance of NHIS as they have established or planning to establish ones;
2. **A national science and technology information policy**. Although national information policies are not the responsibility of the Ministry of Health, but their availability highly influence the development of the NHIS. Eight countries (44%) said the have such policies, while seven (39%) said the country is planning to have such policy, while three (16%) countries do not have it at all;
3. **National master plan for health informatics and telematics**. Eight countries (44%) said they have developed such plans, eight others (44%) said it is being planned while two countries (12%) do not have these plans. Development of a master plan maybe considered as a sign of recognition of the strategic nature of health and medical informatics. Having over 66% of the countries no having a strategy requires attention;
4. **Availability of department for health informatics and telematics the Ministry of Health**. 13 countries (72%) said they have such a department; two countries (11%) are planning to establish a department, while two countries (11%) do not have an IT department. One country did not answer this question. Lack of IT department may hamper the introduction and application of health and medical informatics in the country;
5. **Availability of a specially designed computer centre at the Ministry**. Ten countries (56%) said that the IT centre was especially designed and built for this purpose, while seven (39%) said they are planning to build centres especially for IT and one country said it does not have this facility;
6. **Availability of a Local Area Network** (LAN) which may have personal computers, servers, switches, routers, amplifiers, etc. 13 countries (72%) said they have such a facility; two countries (11%) are planning to establish a department, while three countries (17%) do not have LAN facilities;
7. **Allocation of special annual budget for health informatics and telematics**. 13 countries (72%) said that the government allocates an annual budget for IT support, while one country is considering that and four countries (22%) are not even considering that option. Although the result is encouraging, nevertheless if 22% of the countries do not allocate budget for IT, then IT has some kind of deficiency which requires attention;
8. **Placement of the Informatics and Telematics department on the Ministry Organogram.** 11 countries (61%) indicated that the IT department appear on the

Ministry's organogram, while two countries are planning to do so. A disturbing fact is that four countries or 22% do not have the IT in the structure of the Ministry of Health;

9. **Conduct of planning or evaluation study of the informatics and telematics needs of the Ministry**. A vast majority of 14 countries (78%) said that they have undertaken studies to plan or evaluate IT needs. This is encouraging, but still four countries (22%) are planning or have not done that needs assessment;
10. **Availability of a Ministry web site on the Internet**. 12 countries (67%) said that they have established a web site for the Ministry and gave their URLs. Three countries (16%) are planning for development of web site, while three countries (16%) do not have plans for that. The quality of web sites of health ministries is still to be assessed. Having a web site doesn't by itself satisfy the community;
11. **Availability of Intranet to serve the information needs of the staff and management of the Ministry**. 10 countries indicated that they have established Intranets on their LANs, while three countries (17%) are planning to do so and five countries (28%) don't have Intranet. This is not an unusual result as Intranet is still in its early stages of development in the Region;

3. Analysis of the results of the second set of questions:

The second set is composed of 14 questions aiming at assessing the information technology applications in Ministries of Health in the Region. Four options were provided for each question to indicate whether the computer application/database exists, being planned, in its early stage of development, or fully functional. A weighing system was applied on the scales that was used based on multiplication of the occurrences with the following values: zero if the computer application/database doesn't exist, one if it's being planned, two if it's in its early stage of development and three if it's fully functional. Then the values were added and ranked. The analysis as follows:

RANK	***COMPUTER APPLICATION/DATABASE***	***VALUE***
1.	Health Statistics and Trends Analysis Database (s)	41
2.	Management Information Systems and Applications (Decision Support, Payroll, Personnel, Finance, etc.)	39
3.	Epidemiological Surveillance Database(s)	33
4.	Information Technology Training Programmes for Health Care Professionals	33
5.	Hospital Management Systems (Registration, Electronic Medical Records, Finance, Insurance)	30
6.	Geographic Information Systems (GIS).	30
7.	Computer-Based Directory of National Health Care Institutions (Hospitals, Laboratories, Clinics, Centres of Excellence, etc	27
8.	Computer-Based Directory of Health Care Professionals (Physicians, Radiologists, Dentists, Pharmacists, etc.)	25
9.	Bibliographic, Library and Documentation Database(s)	24
10.	Computer-Based Network of Health Care Institutions (Hospitals, Laboratories, Blood Banks, etc.)	19
11.	Full-text Database(s) for Laws, Legislation, Regulations, etc.	18
12.	Computer-Based Directory of Health and Medical Education (Colleges of Medicine, Dentistry, Pharmacy, Nursing, etc.)	17
13.	E-Health, Tele-medicine, Tele-Radiology, Tele-pathology services.	16

The above analysis indicates that there is a consistent pattern among countries. Those, which have national health information systems, have computer centres, plans, databases and so on. An indication of warning is that many countries have not established systems, haven't allocated funds, haven't developed databases. These require special attention. It is interesting to note that no country has said that it has a fully functional GIS. The vast majority of countries said that they have initiated such activity.

3. **Analysis of the results of the third set of questions:**

The third set is composed of one question with sub-sets aiming at assessing the status human resources working in information technology in Ministries of Health in the Region. A list of job titles was provided and countries were asked to indicate the number of staff working within each category. The analysis shows that a total of 1850 staff work for IT in Ministries of Health in the Region in the following categories: data entry clerks, databases administrators, heads operation, managers, operators, programmers, systems administrators, systems analysis and user support. It is felt that there was some misunderstanding with regard to number of staff and their job titles as they are called by different titles in different countries, so the figures have to be indicative rather than specific. It is worth noting that if we take away the number of data entry clerks (1243), the remaining IT professional categories will make a total of 607 staff in 20 countries within the Ministries of Health. This figure is too small.

9. Impediments for medical informatics development in the EMR (9):

(a) *Lack of awareness.* Many of the health care institutions in the Region have addressed the issue of information technology due to the fact that they don't fully appreciate the impact made by the information technology on medical education and health/medical practice, neither do they appreciate the gravity of lagging behind in this field. When such awareness is present the response for it is usually limited to attempts to introduce computer literacy among staff or students and seeking the use of the technology by senior staff for managerial or data analysis purposes.

(b) *Lack of vision.* Medical informatics is a multidisciplinary professional practice. It requires knowledge of both computer science and medical science. Most of health care leaders are more of health care professionals who have little knowledge in computers. This has lead to lack of comprehensive and long term planning for medical informatics. Response to needs for computerization is usually temporary and short term in nature. Solving the current data processing problems has blinded many managers from thinking about long term or strategic solutions;

(c) *Un-affordability of costs.* Development and maintenance of proper information infrastructure is expensive and its costs are beyond the available budgets of many institutions in the region, particularly when technology is sought for large-scale institutional use. The economic situation and financial constraints in the health care sector, has left many health care units and medical education institutions with proper funding to cater for the basic needs, let alone computerization. Dependence on external resources or funding from donors has become the rule, rather than the exception in introduction of health informatics in the region;

(d) *Limited medical informatics expertise*. None of the countries in the region offers any type of medical informatics education and training. Very few professionals have been lucky enough to get some forms of training abroad. As this area of expertise is still lacking in the region, with little awareness of its value, health care institutions will continue to suffer. Medical informatics has to go parallel with medical education. Medical practice will depend completely on technology, very soon;

(e) *Weakness of the information infrastructure*. Many countries of the region lack the basic information and communication technology infrastructure. Lack of policies for computerization, lack of national information policies, lack of telecommunications facilities, lack of information culture and lack of qualified personnel have lead to low level of adaptation of information technology in the health care sector;

(f) *Absence of legal, legislative, ethical, and constitutional framework*. Most of the countries of the region have not introduced laws and regulations to regulate information technology in general and health informatics in particular. The legal framework will regulate electronic data interchange, access to patients' files, electronic publishing, coding systems, confidentiality and privacy.

10. Conclusion and Recommendations

Health information management is an essential component in the health care system. Health and medical informatics are the tools for health information systems and management. This area of work has not been given the due attention among the health care profession in the Region. Introduction of medical informatics in the health care and medical education system is of prime importance. The following recommendations are for the consideration of the Committee:

FOR MEMBER STATES:

1. Member states should develop master plans for introduction and implementation of medical informatics in health care institutions. Plans should cover the framework defining needs of users, software development policies and standards, phases of implementation, resources requirement and governance and structure;
2. Financial and human resources should be allocated at the national and regional levels to support proper implementation of medical informatics plans;
3. Awareness campaigns should be conducted to sensitise health care professionals on the importance of medical informatics and their specific roles in its adaptation.
4. Member states should develop management information systems for both administration of the health care sector and for the management of the technical programmes;
5. Member states should invest in human resources development in the Information Technology area;

FOR WHO

6. Development of a regional plan for systematic and institutional implementation of health and medical informatics in health care institutions in the region;
7. Development of a model medical informatics curriculum for medical colleges in the region. This course should be introduced during the early years of medical education;
8. Development of a model electronic medical record structure. This model should take into consideration in its design the application of international norms and standards, diversified technological environments, confidentiality and patient rights and legal aspects;

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