Computers In-Patient Care in Bahrain

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RECENTLY, the Ministry of Health undertook a project to initiate the planning and development of a computer based National Health Information System for the State of Bahrain. Under the direction of Dr. Ahmed A. Ahmed of the Health Information Systems Office, the initial stage, or the development of a comprehensive statement of User Requirements, is now nearing completion, and the creation of a specification for the overall design of the system will soon be underway. In contrast to the traditional statistical research systems of the past, the Bahrain Health Information System is being conceived as one which will first provide direct patient care services with needed administrative and statistical data produced as a natural by-product of this function. Since the patient care process is the natural domain of the physician, it is essential that he or she becomes involved in the design and development process as soon as possible. The purpose of this communication is to offer a basis to begin this essential participation by providing a brief introduction to the mechanisms through which these clinical information systems can be expected to operate.

Perhaps the most important fact to be appreciated is that clinical patient care is, after all, an information dependent activity. From the first days of undertaking the study of medicine we begin storing away factual data and information which will later guide us in the management of patient's problems. We then begin confronting patients and learn to collect and prioritize various clinical cues from the history, the physical examination, and laboratory studies in accordance with our previously assembled knowledge and experience. If the computer is to help, it must be able to assist us in performing these fundamental information managment functions more efficiently. Fortunately, the storage and retrieval of data is what the computer does best. As long as it is given the right information to begin with, it can organize and retrieve data with much more precision and accuracy than any human. The important point is that accuracy of data input and appropriate interpretation of any output product remains the responsibility of the clinician-user. Only by optimizing the capabilities of both the clinician and the computer working in concert can the full benefits be achieved so that the management of the patient improves.

The best patient care requires an optimum combination of medical science and a personal, caring attitude on the part of the provider. The essence of medical science is the clinical decision making process; for every physician is called on to make a tremendous number of decisions every day, often on the basis of insufficient evidence and under the pressure of time and always with a calm and steady demeanor which instills patient confidence. One might describe clinical judegement as the ability to make decisions in the face of uncertainty.

We know that clinical decision making is a complex process which is not well understood by anyone. We should expect a clinical information system, therefore, to concentrate first on providing the most basic information on which patient management decisions are made. In Bahrain, these initial efforts would be expected to concentrate on the most essential patient specific data as diagnoses or problem statements, visits, medications, and laboratory test results. Only after fundamental subsystems are operational at both primary and secondary care locations providing efficient and accurate profiles of patients can we anticipate the use of higher level support systems. Much thinking is still required on the part of the users of these systems as to the optimal content and presentation of such information. Experience has shown, however, that even when basic systems become fully functional, patients and doctors perceive an improved quality of care. By keeping this summary data centrally and in an electronic form tied to a National Personal Identification Number, some clinically relevant background information can be made available on the patient no matter when or where they contact the system. With proper design, doctors orders can be captured directly by the system, and requests tracked until appropriate "results" are likewise input by ancillary services. Naturally, in the inpatient setting, this order entry and results reporting process is more intensive, but it is also supportable in the ambulatory setting as well.

Once these fundamental processes are in place, the systems can then begin to provide the means to assist the clinician in handling the massive take of reducing the many clinical cues he is confronted with into good logical patient care management decisions. We know that many of the decisions made every day are relatively simple and

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straight forward responses to explicit clinical data; i.e., giving a childhood immunization, urinalysis for dysuria, potassium check for a patient on digitalis or potassium wasting diuretic, etc. Many of these cues can be explicitly stated by the responsible physicians and often delegated without loss of control of the patient's overall care while at the same time insuring the application of a high standard of care. When such clinical reminders are provided at physician request, measurable improvement in clinical decision making has been demonstrated in repeated studies.

The time honored approach to the dissemination of diagnostic and therapeutic management principles has been the publication of clinical trials or relevant studies in the medical literature generated by the ever increasing advances in biomedical research. After randomly acquiring such information from various journals and symposia, evaluating it, and making a decision about its validity, reliability, and untility within the context of all previously acquired information, the physician must then remember the salient points until confronted with a relevant clinical problem. The application of a-propriate clinical reference information is then directly dependent upon the ability of the health care provider to recall it in sufficient detail to apply it to a particular patient who often may present with several interacting and complex problems. Even under optimal circumstances, these processes of information management place tremendous demands on the physician's analytic, synthetic, and retentive abilities. In reality, memory is often imperfect and is further restricted by fatigue, stress and a demanding schedule. The information contained in the aggregate records of the health information system can be a powerful resource to assist in this process.

Optimal management of patients can benefit from knowledge of how similar patients have responded to various treatment modifiers in the past. This implies that various subgroups of patients having a particular disease or combination of diseases can be identified through various clinical and laboratory descriptions, and that these subgroups have well defined prognostic and therapeutic implications. In fact, there are computer techniques now in use which can facilitate such retrieval and provide the clinician considerable improvement over the usual biases of largely anecdotal experience.

Related to these straight data base retrieval approaches are efforts to formalize the reduction of the vast and overwhelming biomedical literature base into a form which can be more accessable to the clinicians. The aim is to connect the physicians quickly and efficiently to the most approperiate information. To be effective, the system must emphasize an economy of information by careful selection, compaction, and review so that the user can assimilate what is presented with most of the irrelevant information eliminated.

Such computerized "knowledge bases" are now being built to represent something in between a book and a bibliographic search on a topic. The result is a highly organized body of important selected information which is unlike a text in that it is terse and incorporates material from many authors with a wide difference in style and depth of detail. Such reference bases can become an invaluable aid to the busy clinician when they are made available to him at the same computer terminal he uses to acces laboratory results and enter orders.

By use of such clinical information systems we are not finding ourselves with a valuable aid to patient care, but we are gaining useful insight into the process by which we make decisions as well, a fact which can only help us improve. For example, it has been found that clinical judgement is based less on detailed knowledge of pathophysiology than it is on "gross chunks of knowledge" mixed with a good deal of "common sense" experience from which "rules of thumb" are derived. As clinicians, we know a large number of facts, of course, but their use is judgemental : the rules are designed to help one focus attention and generate hypotheses quickly as to the cause of a patient's problem avoiding detailed and time consuming searches through the entire problem space. Certain levels of belief or certainty are recognized as playing a part in the application of rules, but seldom are these certainty concepts used in any formal statistical manner.

Until the recent work with computer systems which are described as having artificial intelligence, this knowledge focus provided a kind of impasse between the clinician and the computer. By the use of these artificial intelligence techniques, computers are now able to assist in the clinical decision making process by presenting data in a way which fits into the clinician's natural framework of diagnostic reasoning. Physicians acceptance has been significant when connections are adequately shown between data gethering, data analysis, and the treatment management recommended. The major breakthrough has come from the inference mechanisms that apply that

knowledge to the data of an individual case, for knowledge bases are known to be constantly subject to change. The inference structures referred to here are often based on symbolic reasoning as well as the more traditional calculations. They may gain their power from qualitative experienrial judgements codified in so-called "heuristics" or rules of thumb just as we have seen with clinicians. They also possess, in many cases, defined methods for quantifying uncertainty which can be combined with the explicit reasoning mechanisms. These are typically computed from uncertainty weights assigned by human experts. The reasoning strategies rely as much on the structure of connections among concepts and facts as on scoring mechanisms. This segmentation of knowledge elicited from experts provides an appealing robustness of performance in the presence of many uncertainty relationships which often characterize a particular patient's problems.

In operation these systems usually begin with an interpretation of a series of data points or clinical cues. This leads to a feed request for more data. The system then proceeds to a global interpretation based on the most likely and coherently structured hypothesis(es). This then generates conclusions which integrates the hypotheses into appropriate management recommendations. Since the clinician is still likely to know additional relevant facts which must be considered, enough flexibility is allowed in the better systems to allow the user to request explainations and possibly change the focus of the reasoning by selectively introducing the new data. The result is a particularly powerful interaction between the physician and the computer with unparalleled improvements in the potential for clinincal decision making when it is combined with a terminal interface which is easy for the non-computer oriented health professional to use.

This review has attempted to provide the reader with some insights into just how the Bahrain Health Information System might be used to provide some very real support for direct patient care. Hopefully, it has demonstrated the fact that we now have at our disposal a host of various systems designed to support the physician in the clinical decision making process. We know that our current methods of data gatheing are often demonstrably haphazard. There is a vast opportunity for "normalization" of terminology, reduction of observer variations, and correlation of clinical data from many sources into explicit and efficient patient care management strategies.

Computers can clearly help in data collection, and assist in its analysis by helping us recall important facts, helping us discriminate among important clinical cues, and call into play well established clinical management strategies in an objective and highly efficient means. The purpose of the clinical information system is to put relevant, important, and high quality knowledge into the hands of physician-users at the time of their information needs, and to martial the published authority behind those judgements. The objective is not to intervence directly into the diagnostic or therapeutic decision making process, but simply to make well organized easily accessable information available for use by the practitioner as appropriate to the clinical setting. The value comes in its ability to influence clinicians only by removing that part of inappropriate decision making that stems from the lack of needed information presented in conviently accessable and timely way. Thus it is only another tool in the vast armamentarium of today's clinical practice, but one which must have the input of the user to shape it into its true potential.

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