Defence Science Journal, Vol 47, No 4, October 1997, pp. 499-504

Role of Medical Expert Systems in Health Care in the Indian Context

A. Kandaswamy and A. Sukesh Kumar
P.S.G. College of Technology, Coimbatore-641 004

ABSTRACT

In this article, the authors introduce a medical expert system aimed at assisting physicians in the diagnosis, treatment and management of diseases. Some medical expert systems which can be used in hospitals in India are listed. The list has been compiled on the basis of an elaborate review of medical expert systems from literature covering the period 1975-95. The authors give suggestions for exploiting medical expert systems to improve the health care delivery system in the country. Need for the development of medical expert systems for exclusive use of defence personnel is discussed.

1. INTRODUCTION

Today, we are badly in need of a health care system for perceiving the symptoms and syndromes of various diseases because of the unstinted faith of the medical world in the motto 'prevention is better than cure'. Later, the slogan 'health for all in 2000 AD' was adopted. But successful realisation of this goal is hardly possible without emphasis on implementation of modern technology and advanced investigations in the field of health. Computer technology has had its impact on the practice of medicine in dramatic ways. The idea of computer programs that can directly assist the physician in decision-making is both intriguing and disconcerting. On analysing recent developments in medical computer science, it becomes clear that the trend is to develop new methods for computer-aided decision-making in medicine and to evaluate critically these methods in clinical practice. In phase with the above, development and implementation of medical expert systems (MES) in all fields of medicine is being suggested for providing better health care.

The MES are very helpful to the medical profession. For defence personnel, it is essential to maintain periodic records of physiological parameters to ascertain their physical fitness, apart from identifying the disease whenever they are ill. Maintaining a record of each person is also very important in defence organisations. Medical record can be added as a knowledge base in the expert system developed for diagnostic application. Also in defence, the different types of injuries and wounds which are common during wartime and other calamity control periods may be taken care of. For this purpose, MES has to be developed exclusively for the defence personnel by the biomedical engineering department. Some of the MES like NEUROLOGIST-1, OVERSEER and PEC (Table 1) are specially good for periodic check for neurologic fitness, soundness of mind and eyesight, which are essential health requirements for defence personnel.

2. EXPERT SYSTEMS

Artificial intelligence (AI) may be defined as the branch of computer science concerned with the

Received 25 June 1997

automation of intelligent behaviour. AI provides a simple structured approach for designing complex decision-making programmes. In fact, AI is simply the transfer of intelligence to machines. The biggest single use of AI technique today is in expert systems. An expert system is a rule-based AI application program that provides expert quality solutions to problems in a specific domain. Its knowledge is extracted from human experts in the domain and encoded in a formal language; it attempts to emulate their methodology and performance. These systems are open to inspection, modification, analysis and heuristics[1-3]. Personnel involved in the development of an expert system are: (i) the domain expert, (ii) the knowledge engineer, and (iii) the end user.

3. MEDICAL EXPERT SYSTEMS

Expert systems in the field of medicine are generally called MES. These systems are based on symbolic models of disease entities and their relationships with patient factors and clinical manifestations. Diagnostic expert systems help the doctors to determine a range of alternative diagnosis or a definitive diagnoses. Quick decision-making in differential diagnosis and selection of proper treatment in a short time are the prominent features of MES. The main applications of MES are diagnosis, monitoring, debugging (diagnosis and remedy), making computer-aided instructions or tutoring (helpful for medical students) and control (monitoring, diagnosis, debugging and prediction).

4. [redacted] SYSTEMS

Today, a reasonably good number of MES are available for online application encompassing the entire area of medical field. MYCIN[4] was the first expert system in medicine which was developed in the mid seventies. A list of a good number of popular and widely used MES are available with the authors. This has become possible through literature survey and compendex search (from online CD-based literature search) for the period 1970-95[5-8]. Suggested list of MES which can be used by Indian doctors in hospitals is given in Table 1.

Expert systems 1 to 17 in Table 1, are for diagnosis purposes. This will be very helpful for the physicians in decision-making. All clinical and qualitative information will definitely be taken into account, since this information is mandatory to the expert systems for decision-making. Expert systems 18-23 are mainly useful for medical and paramedical staff for assessing the latest status of the patient through ongoing information in the monitoring devices. It can be used in operation theatres, intensive care units or in post-operative units. Expert systems 24-29 can be used for the management of certain patients. Management of diseases on each patient has to be done with utmost care, since forecasting, prediction and extra-polation of the present condition are not an accurate and fully workable practice in medicine. The same disease with the same intensity may manifest and affect unpredictably in different ways in different patients, since attack of any disease and its behaviour are linked to several factors which inherently differ from individual to individual based on their health condition, immunity factors, genetic orders, etc. All these factors stress the requirement of individual attention on each patient in his ailment. Certain diseases cannot be cured in a short duration. Close follow up and continuous treatment of the patient are required for the control of the disease. For disease management, a physician requires to have a formidable amount of knowledge and considerable amount of time. Caring for such patients calls for a multi-disciplinary approach encompassing different fields of medicine. For most doctors, this knowledge comes with time and experience. Hence, expert systems for the management and control of diseases are highly useful in taking proper decisions on treatment. They help to store and retrieve patient history and information like

Table MES for diagnosis, monitoring and management

Sl.No	Expert System	Application
	AGECAT	To diagnose psychiatric disorders in elderly
2	ANEMIA	To diagnose the diseases treated by haematologist
3	AI/RHEUM	For diagnosing rheumatological diseases
4	CARDIAC	For clinical diagnosis of cardiovascular diseases
5	CASNET	To diagnose glaucoma and prescribe treatment
6	CORONARIA	For diagnosis and therapy of ischemic diseases
	GLADYS	Diagnostic system for dyspepsia
8	LIPPDIAG	To diagnose leprosy
9	LITO-1	To diagnose jaundice
10	NEUROLOGIST-11	To diagnose neurological diseases
11	ONE	To diagnose vertigo
12	OVERSEER	To diagnose psychiatry disorders
13	PATHEX	To diagnose liver diseases
14	PEC	In the diagnosis and treatment of common and potentially blinding eye disorders
15	PIP	For diagnosis of kidney abnormalities
16	PSYCHE	For diagnosis of mental diseases
17	VERTIGO	To diagnose otoneurological problems
18	ATTENDING	For the anaesthetic management of a patient
19	ONCOCIN	To implement oncology protocols
20	VM	For ventilatory management
21	BABY	For ICU for new born to monitor patients
22	GUARDIAN	For intensive care monitoring
23	ARRES	For monitoring the post-anesthetic care unit
24	DIABETA	For the management of diabetes
25	MEDICO	For advice regarding the management of chorioretinal diseases
26	MONITOR	For cystic fibrosis patient management
27	VENTEX	For decision-making in the management of ventilator therapy
28	UVEITIS	For diagnosis and management in ophthalmology
29	TBMEX	For the management of tuberculosis

severity of the disease, the course of treatment, efficacy of different drugs on the patient, period for which it has affected the patient, various other ailments apart from the management-intended ailment, etc. It is highly helpful for all the specialists in medicine. By just entering the patient identification number, he can access the patient data file and exactly assess the latest condition of the patient. In fact, the patient can now be offered enhanced capability to survive or survive effectively. The physician can be offered enhanced capability to identify and categorise the need for medical or surgical treatment. The physician is always well aware of the status of his patient.

5. RECENT TRENDS

The primary mechanism of MES built in the 1980's was production rule system, which uses a collection of facts about a specific area of knowledge and makes deductions using techniques

of logical inference. This traditional type of production expert system is not suitable for large amorphous collections of rules, because the performance of the system will be degraded as the system size scales up. It is not easy to expand, debug and reuse as the size of the production rule-set gets larger and larger. Of late, recently new trends have been emerging to overcome the above difficulties. Now-a-days, artificial neural networks[9], object-oriented frameworks[10], fuzzy logic[11], genetic algorithms[12], hypertext/ hypermedia techniques[13], probabilistic methods[14], etc. are largely used for the development of faster, efficient and reliable MES.

6. APPLICATION OF MES IN THE INDIAN CONTEXT

The health care system in most parts of the rural areas is not up to the mark in India. But we have seen that a large number of MES covering almost the entire gamut of human physiology system are available at least in prototype forms. To make them active in hospitals, the essential requirement is a computer platform.

The computers have already established their impact in all walks of life. The rising tendency of the growth rate of the Indian economy has been possible only because of the efficient utility of computers in all sectors. Policies like reduction in customs duty on import of computer and related items, liberalised entry of multinational companies, etc. have helped in promoting the use of computers in all activities. Most of the city-based hospitals, health care centres and medical-related research institutions of the country are now-a-days using computers in the following areas on a large scale:

- Organisation and management of establishments

  Patient management
- Clinical evaluation and analysis
- Information storage and retrieval
- Diagnostic purposes
- Therapeutic purposes, etc.

Growth of computer industry in India has made the cost of computer affordable. In the manufacturing sector, the chances of indigenous development of computer systems are quite bright. Hence, through dedicated efforts, installation of computers in hospitals in all parts of the country can be taken up step by step. The computer networks can be utilised for making available the MES to user institutions through an organised agency. Organisations like the Indian Medical Council, Indian Council of Medical Research and some other government agencies working in the area of health care can be entrusted this task.

7. DEVELOPMENT OF MES IN THE INDIAN CONTEXT

Even though there are positive development in respect of health care activities in the country, exploitation of full potential of advanced medical technology has not yet attempted. Still, we are not in a position to control sudden outbreaks of epidemics like chickenpox, malaria, plague, Japanese encephalitis, etc. Very recently, in Kerala, due to outbreak of Japanese encephalitis, about 30 people lost their lives in various parts of the state within a span of two weeks. It took 15 days to exactly identify the disease. There are several preventive techniques for controlling most of the above mentioned diseases and they can be effectively controlled at the initial stage itself if they are identified exactly. Here comes the necessity of development of MES. The MES for clinical investigations for the above diseases can be developed and made available to all parts of the country through computers. On the arrival of the first case itself, investigations can be initiated through MES and then preventive measures can be started on war footing; thereby many precious lives of our citizens can be saved. Development of appropiate MES can be entrusted to any premier medical research institution of the country. Undoubtedly, development of efficient MES suitable under Indian conditions would ultimately help the country to solve the health care problems

to an extent as a step towards finding reasonable solution for a socio-economic problems.

8. CONCLUSION

The MES are already supporting many problem-solving programmes, such as decision-making, designing, planning, monitoring, diagnosing, treating and training activities. But to make them more effective, this emerging technology must percolate to the level of practising doctors. As a first step towards implementation, it is essential to introduce computer-aided diagnosis techniques and medical informatics in the curricula of every medical/paramedical institution so as to familiarise medical students/nursing students with the use of new technology in making diagnoses.

ACKNOWLEDGEMENT

The authors thank Dr P. Radhakrishnan, Principal, PSG College of Technology and Dr V. Subbaih, Head of the Department of Electrical & Electronics Engineering, PSG College of Technology, Coimbatore, for providing research facilities and encouragement.

REFERENCES

Mathew, M. A. Lecture notes for a course on artificial intelligence and expert systems. Tech. Publishers, India, 1994. p. 107.

2 Eugene Charniak & Drew McDermott. Introduction to artificial intelligence, Addison-Wesley Publishing Co., UK, 1985. p. 225.

3 Robert I. Levine; Diane E. Drange & Barry Edelson. A comprehensive Guide to AI and expert systems, International editions, Mc Graw-Hill, 1986. p.285.

4 Shortliffe, E.H. Computer-based medical consultation, MYCIN. Elsevier, New York, 1976. p.145.

5 Rogers, W. *et al.* Computer-aided medical diagnosis; Literature review. *Int. J. Biomedi. Computing*, 1979, **10**, 267-89.

6 Chandrasekaran, B. & Smith Jack, W. Tenth annual workshop on artficial intelligence in medicine: An overview. *The AI Magazine*, 1985, 84-90.

7 Richard K. Miller & Terri C. Walker. Artificial intelligence applications in sensors and instrumentation. SEAI Technical Publications, 1988, p.111.

8 Compendex, Online Literature search through NCSI, Indian Institute of Science, Bangalore. 1996.

9. Economou, G.P.K.; Hallas, J.A.; Mariattos, E.P & Goutis, C.E. Artificial neural networks in medical decision-making systems: An application to pulmonary diseases diagnostic through very high speed digital logic synthesis. Proceedings of European Design and Test Conference, IEEE, 1995. 590-95.

10 Curtis, H.K.; Tsang & Curtis Bloor. Medical expert system using object-oriented framework. IEEE Symposium on Computer-based Medical Systems, 1994, 176-81.

Sidaoui Hassan; De Albuquerque; Antonio, R.P.L.; Benjamins Richard & Isotani Sadao. Fuzzy approach with a multiexpert approximate knowledge representation for medical diagnostic. Proceedings of the IEEE International Conference on systems, *Man and Cybernetics*, 1994, **3**, 2290-93.

2 Zhang Lei, *et al.* On rule checking and learning in an acupuncture diagnosis fuzzy expert system by genetic algorithm, 4th IEEE International Conference on Fuzzy System,1995, **2**, 625-30.

3 Chiu Deng Y.; Chang Chung C.; Evena Martha W. & Chern Johng C. Complete hypermedia medical decision analysis support system: IEEE Symposium on Computer-based Medical Systems. 1994, 16-21.

4 Todd Bryan S.; Stamper Richard & MacPheson Paul. Probabilistic rule-based expert system. *Int. J. Biomedi. Computing*, 1993, **33**(2), 129-48.

Contributors

Mr A Kandaswamy did his MSc (Engg) in Applied Electronics from Madras University in 1974, and PhD in Electrical Engineering from Bharathiyar University in 1992. Since 1988, he is Professor at PSG College of Technology, Coimbatore. His areas of research include: biomedical, instrumentation, medical imaging, digital signal processing, digital image processing and software development for medical applications. He is the Principal Investigator for several Central Government funded projects. He has published several technical papers. He is a member of the Institute of Electrical and Electronics Engineers Inc., USA, a fellow of Institution of Engineers (India) and a life member of Biomedical Engineering Society of India, Indian Society of Technical Education, Computer Society of India and System Society of India.

Mr A Sukesh Kumar did his ME (Electronics) and Telecommunication Engineering, from Jadavpur University, Calcutta, in 1988. At present, he is working as Assistant Professor at the Government Engineering College, Thiruvananthapuram, Kerala, which he joined in 1984 as Lecturer. His areas of research include: biomedical, instrumentation, medical imaging and software development for medical applications. He has published 20 technical papers in international/ national conferences/symposia/journals. He is a member of the Institute of Electrical and Electronics Engineers Inc. (USA), a life member of Biomedical Engineering Society of India, Indian Society of Technical Education and System Society of India.