

# The Role of Medical Expert Systems in Pakistan

Fahad Shahbaz Khan, Fahad Maqbool, Saad Razzaq, Kashif Irfan, and Tehseen Zia

**Abstract**—Expert systems are used extensively in many domains. This paper discusses the use of medical expert systems in Pakistan. Countries all over the world pay special attention on health facilities. A country like Pakistan faces a lot of trouble in health sector. Several attempts have been made in Pakistan to improve the health conditions of the people but the situation is still not encouraging. There is a shortage of doctors and other trained personnel in Pakistan. Expert systems can play a vital role in such cases where the medical expert is not readily available. The purpose of this paper is to analyze the role that such systems can play in improving the health conditions of the people in Pakistan.

**Keywords**—Medical Diagnostics, Expert Systems, Pakistan.

## I. AN OVERVIEW OF EXPERT SYSTEMS

**E**XPERT systems are computer programs that are meant to solve real world problems. In normal routine these problems are solved by domain experts who are experts in their respective domains. Thus the knowledge has to be extracted from the domain expert in order to develop an expert system. Extracting the knowledge from a domain expert and to convert it into a computer program is a difficult task. This task of extracting the knowledge from a domain expert is performed by a Knowledge Engineer. The knowledge engineer provides useful assistance to domain experts in determining the representation of knowledge. If the knowledge is represented in the form of rules then such systems are called Rule-based expert systems. Different techniques have been developed for knowledge acquisition. Fig. 1 shows different modules for a rule-based expert system.

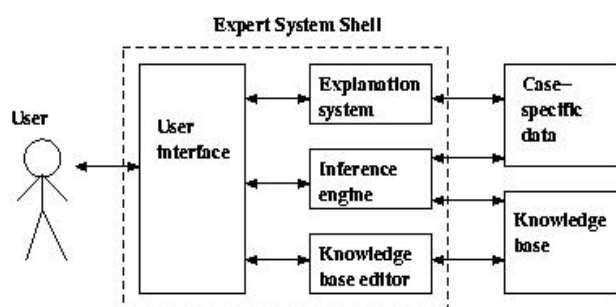


Fig. 1 Expert System Architecture [1]

The interaction with the expert system is made through User Interface [6]. The interaction is performed through an interactive dialog, an example of which is given below [6]:

Q. Do you have good mathematical skills?  
A. Yes.  
Q. Do you have good statistical skills?  
A. Yes.  
Q. Have you studied physics previously?  
A. No.  
Q. How much marks you got in your Bachelor studies?  
A. 650.

The Knowledge Base is the heart of an expert system. Typically the knowledge base is in the form of IF-THEN rules. The inference engine finds a sequence in which inferences are made. The inference engine is used to reason with the knowledge base. In forward chaining rule-based systems Case Specific Data is also called Working Memory [1]. The working memory contains the result of inference process. Expert systems also facilitate the users by providing Explanation Subsystem. The explanation subsystem explains its reasoning to the users. Knowledge base editor is provided in some systems for writing and updating the knowledge base. Expert systems have the ability to separate problem specific knowledge from general purpose reasoning. This general purpose block (as shown in Fig. 1) without any domain specific knowledge is called skeletal systems, or expert system shells. Many commercial shells are available these days. Thus expert systems are a combination of expert system shell and domain specific knowledge.

Expert System= Expert System Shell + Knowledge Base

## II. MEDICAL EXPERT SYSTEMS

There are many applications of expert systems ranging from medicine, accounting, process control to human resources, financial services etc. Most applications of expert systems in medicine involve predicting and diagnosing a particular disease. But expert systems are now involved in many other roles in clinical care such as disease prevention, therapy, rehabilitation of the patient after therapy etc. Expert systems are used in medicine to train the medical students on various medical tasks. Medical expert systems are also useful in certain situations where either the case is quite complex or there is no medical experts readily available for patients. From the very beginning the main obstacle of using expert systems in medicine has been the accuracy of such systems. The field of medicine is such a complex and sophisticated one that safety is always a major issue. But still such systems

provide support in places where there is shortage of medical experts. MYCIN, PUFF, DXplain, HELP etc. are some of the famous medical expert systems.

### III. TOOLS FOR CONSTRUCTING MEDICAL EXPERT SYSTEMS

Medical expert systems can be constructed either through AI languages or from expert systems shells. Expert system shells provide more general facilities and an easy way to enter necessary knowledge about the problem domain. ESTA, EXSYS, XpertRule, ACQUIRE, FLEX etc. are some of the popular Software packages used in the construction of medical expert systems. LISP and PROLOG are two famous AI languages used to develop medical expert systems.

### IV. SCOPE OF MEDICAL EXPERT SYSTEMS IN PAKISTAN

Pakistan is situated in the north-western part of South Asian subcontinent. The population of Pakistan in 2002 according to Population Association of Pakistan [2] was 14.5 million. Fig. 2 shows population pyramid of Pakistan [2].

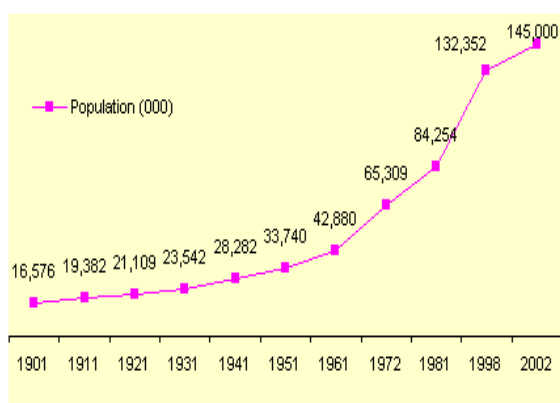


Fig. 2 Population of Pakistan (1901-2002) from census [2]

Year	Hospitals	Dispensaries	Maternity and Child Health Centres	Rural Health Centre	Basic Health Unit	T.B. Clinic	Total Beds
1947	292	722	91				13769
1955	333	984	198				19197
1960	342	1195	384				22100
1965	379	1695	554				25603
1970	411	1875	688				28976
1975	518	2908	696	134	373	89	37776
1980	602	3466	812	217	736	98	47412
1985	652	3415	778	334	2647	100	55886
1990	735	3714	1057	459	4213	220	72997
1995	827	4253	864	498	4986	260	85805
2000	876	4635	856	531	5171	274	93907

Fig. 3 Health establishments in Pakistan (50 years of Pakistan, Federal Bureau of Statistics, and government of Pakistan) [2]

The ever increasing population rate of Pakistan means a need of more health personnel. There is also a shortage of hospitals, dispensaries, maternity and child health centres. The problem is even worse in rural areas where there are very less number of health centres. Fig. 3 shows health establishments in Pakistan from 1947 to 2000.

Fig. 3 reflects some facts especially the shortage of health facilities in rural areas. These facts and figures are also supported by the availability of health personnel. Fig. 4 shows the number of doctors, nurses, LHV and dentists available for general public.

Years	Doctors	Nurses	Nurses per 1,000 Doctors	Dentists	LHV	Registered Midwives
1950	2,298	418	182		67	10
1955	3,923	963	245		142	30
1960	6,485	1,929	297		230	128
1965	10,682	2,945	276		627	291
1970	14,109	4,543	322		1169	616
1975	17,887	6,144	343		1636	
1980	23,594	9,098	386	928	2009	4200
1985	30,044	10,529	350	1416	1574	8133
1990	51,883	16,948	327	2077	3106	15009
1995	69,691	22,299	320	2751	4185	20190
2000	91,823	37623	410	4175	5619	22528

Fig. 4 Health Personnel in Pakistan 1950 to 2000 (50 years of Pakistan, Federal Bureau of Statistics, and government of Pakistan) [2]

The health personnel to population ratio in Pakistan have improved over the past two decades. But majority of these health personnel are available in urban areas. The rural areas have still very low health professionals to population ratio. Fig. 5 shows selected health deprivation indicators of Pakistan [2].

Years	Population With Access to Safe Water %	Population With Access to Sanitation %	Population With Access to Health Services %	Population With Access to Essential Drugs %	% Underweight Children (Under Age 5)
1988-1991	56	24	90	---	42
1990-96	74	47	55	---	38
2000	88	61	---	50-79	38

Fig. 5 Selected health deprivation indicators of Pakistan (UNDP, Human Development Report) [2]

This shows that many people are still living without general health facilities (like essential drugs, safe water etc.). Medical expert systems can play here a major role by providing support in common clinical problems like prediction of diseases, prevention of diseases, diagnosis of diseases, counseling of the patients etc. Such programs would be very handfull in rural areas where there is a shortage of health personnel. Medical expert systems can be used for most frequent diseases which are effecting the population (both in rural and urban areas). Fig. 6 shows causes of deaths in Pakistan [2].

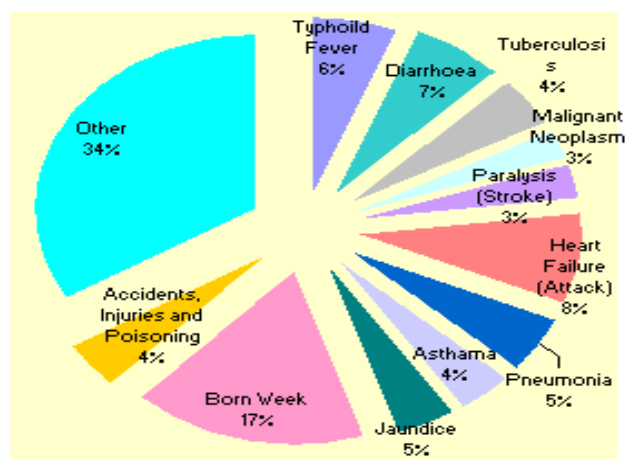


Fig. 6 Causes of deaths, 2000, Pakistan (Pakistan Demographic Survey 2000, Federal Bureau of Statistics, Government of Pakistan) [2]

Several factors such as poverty, low educational level, inadequate sanitation and water supplies to the population contribute with the poor health status of Pakistan.

## V. RELATED WORK

### A. Assessment of Health Status and Trends in Pakistan [3]

The focus is on the most important health and disease issues facing the health of the nation. Women and children are affected with the most persistent health burden in Pakistan. Pakistan is also facing rapid population growth since inception. The main causes of death in children are diarrhea, malnutrition, acute reparatory infections and vaccine preventable diseases. There are also concerns regarding the persistence of tuberculosis, malaria and typhoid fever.

### B. Pakistan's Maternal and Child health Policy: Analysis, Lessons, and the Way Forward [4]

The paper provides an analysis of Pakistan's maternal and child health (MCH) and family planning (FP) policy over the period 1990-2002. It also focuses on macroeconomic influences, priority programs and gaps, adequacy of resources, equity and organizational aspects, and the process of policy formulation. Communicable diseases and reproductive health (RH) problems, which are largely preventable account for over 50% of the disease burden.

### C. Expert systems in medicine: academic illusion or real power? [5]

The paper reflects the role of expert systems in medicine and addresses their future as well as the trends that are foreseen in this area. An analysis of the role of expert systems in health care over the next decade is given. The objective of the paper is to identify the key clinical areas that will require computerized decision support and the role of expert system as a key enabling technology.

## VI. CONCLUSION

The paper presents the use of expert systems in health care in Pakistan. The idea is to use expert systems to provide support in common clinical problems like prediction of diseases, diagnosis of diseases etc. Such programs could be really useful in rural areas where there is a vast shortage of health personnel. We are in a process of creating such a system for typhoid fever. There are still some problems in creating such systems as most people in rural areas of Pakistan are illiterate and computer literacy cannot be expected from them. Such expert systems are needed to be developed in regional languages. Such systems are required to make available to village area through blocks or village administration units. In addition to this the possibility to communicate with the system by text, pictures and sounds will provide extra advantages. Adding speech interface to such systems may be proved to more beneficial to the people of remote areas. Even illiterate people can interact with speech interface based expert systems and get benefits. However this is still a goal to be achieved.

## ACKNOWLEDGMENT

We would like to thank Population Association of Pakistan, Federal Bureau of Statistics. We would also like to thank the Population Census Organization, an attached department of Statistics Division. All the statistical information has been collected from their websites.

## REFERENCES

- [1] Alison Cawsey, Introductory AI course, available at <http://www.macs.hw.ac.uk/~alison/ai3notes/all.html>, accessed 30/12/07.
- [2] [www.pap.org.pk/Statistics.htm](http://www.pap.org.pk/Statistics.htm), accessed 06/08/26.
- [3] Assessment of Health Status and Trends in Pakistan, DRAFT June 11, 2001, Community Medicine Residency Program, Department of Community Sciences, AKU, available at [http://66.216.90.50/CHS/pdf/Health\\_SituationandTrend-Pakistan,2001.pdf](http://66.216.90.50/CHS/pdf/Health_SituationandTrend-Pakistan,2001.pdf).
- [4] S. Siddiqi, I. U. Haq, A. Ghaffar, T. Akhtar and R. Mahaini, Pakistan's Maternal and Child health Policy: Analysis, Lessons, and the Way Forward, Health Policy 2004; 69: 117-130.
- [5] Kostas S. Metaxiotis, Emanuel Samouilidis: Expert systems in medicine: academic illusion or real power? *Inf. Manag. Comput. Security* 8(2): 75-79 (2000).
- [6] [http://en.wikipedia.org/wiki/Expert\\_system](http://en.wikipedia.org/wiki/Expert_system), accessed 30/12/07.