

The Role of Medical Expert Systems in Pakistan

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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

EXPERT 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.

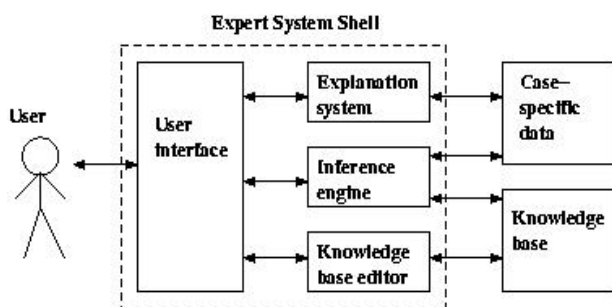


Fig. 1 Expert System Architecture [1]

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

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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].

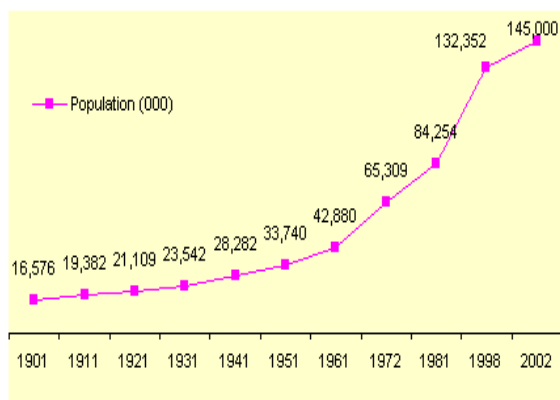


Fig. 2 Population of Pakistan (1901-2002) from census [2]

| 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].

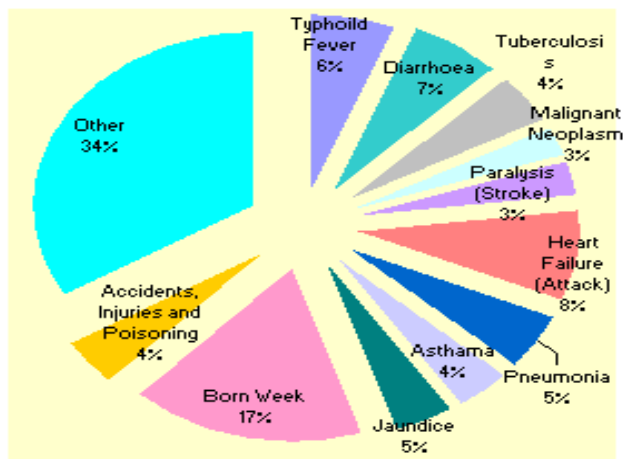


Fig. 6 Causes of deaths, 2000, Pakistan (Pakistan Demographic Survey 2000, Federal Bureau of Statistics, Government of Pakistan) [2]

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.

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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, 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.
- [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, accessed 30/12/07.