CHAPTER 1

Introduction

1.1. Health care

Health is wealth. Every nation should provide proper health services to her every citizen. Health status of every individual is equally important. But, however, children are very important to the nation’s present and its future. Parents and relatives are usually committed to ensuring that they are healthy and have the opportunities that they need to fulfill their potential. Yet communities vary considerably in their commitment to the collective health of children. This is reflected in the ways in which communities address their collective commitment to children, specifically to their health.

In recent years, there has been an increased focus on issues that affect children and on improving their health. Children form the largest proportion of reactive workload in primary healthcare. Children are vital to the nation’s present and its future. All children need and deserve a healthy start - to be properly nourished before birth, in infancy, and during their growing years to receive basic health care both prenatally and during the crucial early years after birth. Scientific and public health advances have improved access to health care and hence, reduced child mortality and morbidity from infectious diseases and accidental causes. Chapter 2 of this thesis has been devoted to have an account of the global as well as Indian scenario and this account demands much more attention towards the paediatric domain. Promoting health services today requires consideration of the overall status of children, not just identification and treatment of specific diseases or injuries.

The total paediatric age group is subdivided as: Foetal (Conception - birth), Neonates (0-4 weeks), Infants (4 weeks -1 year), Toddler (1 year - 3 years), Pre-school (3 years - 5 years), School going (5 years - 10 years) and Adolescence (10 years - 18 years). It should be pointed out that the disease pattern, drug selection, diet, health teaching, common rearing technologies are different for different paediatric age groups.

Children are generally viewed as healthy when they are assessed by adult standards, and there has been a great deal of progress in reducing childhood death and diseases. But the country should not be blinded by these facts—several indicators of children’s health point to the need for further
improvement. Recent improvements in children's health need to be sustained and further efforts are needed to optimize it. To accomplish this, the nation must have an improved understanding of the factors that affect health and effective strategies for measuring, accessing and using information on children's health.

1.2. Examination procedures to paediatric patients

Usually, the examinations are done using the following four steps in order:

![Fig. 1.1. Examination procedures](image)

**Inspection** is the act of visual examination of the external surface of the body as well as of its movements and posture. **Palpation** is the process of examining by application of the hands or fingers to the external surface of the body to detect evidence of disease or abnormalities in the various organs. **Percussion** is the process of use of the finger tips to tap the body lightly but sharply to determine position, size, and consistency of an underlying structure and the presence of fluid or pus in a cavity. **Auscultation** is the process of listening for sounds within the body, usually to sounds of thoracic or abdominal viscera, in order to detect some abnormal condition, or to detect foetal heart sounds.

The examination steps should be followed in every case so that it should be methodological. Paediatric patients may be non-cooperative, hostile and resistant to such examinations and therefore, examination steps may have to be altered. For example, very often auscultation is done before palpation and percussion when the baby is quite and co-operative before he turns hostile owing to various examination procedures.

For the paediatric patients, there is a special importance of congenital anomalies affecting normal growth and development. The primary reasons why the under-fives deserve special health care may be stated as follows:

(a) Large in number: According to the 2005, SR report of Govt. of India, children of the age group 0-4 years constitute about 10.4% of the total population. They are entitled to receive a large share of health care as per the percentage.
(b) Mortality: In India, 17.3% [1] of deaths occur in children under the age of 4 years. The major causes of death in this age group are neonatal causes (45.2%), diarrhoeal diseases (20.3%), pneumonia (18.5%) - all preventable. We could avoid almost all deaths by taking prompt and effective use available means of treatment and prevention.

(c) Morbidity: The initial first 5 years of life span are full of health hazards - e.g. malnutrition and infectious diseases (e.g. whooping cough, tetanus, polio). It is well-known that there is a great prevalence of intestinal parasites of this age group.

(d) Human resource: It is certainly a proper investment for the future to ensure child health.

(e) Growth and development: Under fives period is one of rapid growth and development and needs a special care.

'Under-fives' clinic in India [2] is displayed for the health care management for under-fives. The aims and objective of the clinic is illustrated using the symbol as depicted in fig. 1.2.

![Fig.1.2. Symbol for under-fives’ clinic]
Prevention is better than cure. So, the prime issues - preventive and illness care need to be addressed properly.

Preventive care includes:

- Regular health check-up;
- Immunization;
- Nutritional surveillance;
- Oral rehydration;
- Family planning; and
- Health teaching.

Illness care includes:

- Diagnosis and treatment of:
  a) Acute illness;
  b) Chronic illness including congenital, physical, mental and acquired abnormalities;
  c) Disorders of growth and development;
- Laboratory services (pathological, x-ray etc.)
- Referral services.

Two ecological base factors are important for defining the health status of an individual, the internal environment of a child itself including heredity and the external environment or the surroundings. A proper balance between these two factors is required for the normal growth and development of a child. The racial and genetic characteristics are the major components of the internal environment. The external environment is governed mostly by water, housing, food, education and sanitation which are controllable factors. ‘External environment’ is also termed ‘environmental health’ [2] by WHO (World Health Organisation).

Next, one has to find out the status of neonatal mortality. It is reported by UNICEF [3] that most neonatal deaths occur within 24 hours of birth - a child is about 500 times more likely to die in the first day of life than at one month of age. Globally, neonatal mortality accounted for almost 37 per cent of all under-five deaths in 2005 for which it is 64% to Asia-Pacific. The largest absolute number of newborn deaths in the world occurs in South Asia - India contributes around one quarter of the global total. In fact, of the 10 countries in the world that account for the highest number of newborn deaths, 6 of them -
Afghanistan, Bangladesh, China, India, Indonesia and Pakistan - are in the Asia-Pacific region.

It is to mention here the high burden of neonatal deaths is related to insufficient maternal healthcare services, maternal under-nutrition and cultural practices surrounding the birth process and disease. According to WHO estimates, around 3% of approximately 120 million infants born every year in developing countries develop birth asphyxia requiring resuscitation. It is estimated that some 900,000 of these newborns die each year [4]. A survey of 127 institutions in 16 developed and developing countries has shown that there was often no basic resuscitation equipment, or that it was in poor condition, and that health personnel were not properly trained in newborn resuscitation [5]. Moreover, globally more than 1 million children who survive birth asphyxia each year go on to suffer such problems as cerebral palsy, learning difficulties and other disabilities.

It is demanding to consider two matters concurrently: (i) improving the environmental health and (ii) improved health care management. Regarding the first matter different developing countries including India are taking actions by providing drinking water at per WHO specifications as well as supplying supplementary food to them. This work mainly concentrates on the second issue i.e., improved health care management. For the proper paediatric care the role of a paediatrician is pivotal. From the table 9.2 (chapter 9) we get a picture of the availability of paediatricians working in rural regions of India what is not at all satisfactory. They are really a scarce commodity at per the requirements in general and specially for rural region of a developing country like India.

To cover the complexity of the domain as well as mitigating the scarcity of domain experts one may consider an automated consultation system in an expert system framework as an alternative. Starting from MYCIN [6], a good number of attempts have been made to develop such expert systems in medicine with their relative success and failure. We may cite a lot of medical expert system (detail discussion in chapter 4) for well-being of paediatric problems, but, however, to the best of our knowledge, not so much of the issues relating to paediatric health care management especially for new-born child (prevention of child mortality) and the most occurrence in every child's life i.e fever management by parents (health teaching) have been addressed. In this work an attempt has been made towards the development of medical consultation systems for the domain in an expert systems framework to partially meet up the requirements of the paediatric domain.
1.3. Usage and benefits

Before the development of an expert system starts, the issues related to its usage and benefits should be addressed for its successful use. Various aspects of the usage issues are particularly important such as (i) benefits of usage of the system to different potential users; (ii) who will use it and how; (iii) what are/will be the expected reactions of various people in using such a system; (iv) what problems users might face and how to overcome or minimise such problems; and (v) how the question-answer sequence should be tailored.

1.3.1. Levels of usage of a technical artifact

It is suspected that there are three levels [7, 8] of human computer interaction: physical, task and organisational. The physical level is concerned with the user interface. At the task level, the business tasks that the primary user undertakes while at the user interface. At the organisational level is concerned with the organisational purpose of the tasks which suggests that benefits which stem from such interaction can also be separated into three types, corresponding to three levels. For example, speedier access to functionality might be a benefit of an improved user interface. Obtaining a budget estimate with less time would be a benefit at the task level. And speedier completion of the project proposal would be a benefit at the organisational level.

In an another similar study, Hart [9] discerns three levels at which we can discuss and describe the usage of a technological artifact. He cited the example of using a telephone. At the lowest level, we talk in terms of movements of hand, arm and finger which describe the picking up of the phone and dialing. Consideration of the size of people's fingers and of buttons is validly carried out at this level. At the next level we talk in terms of phoning a certain person. We talk in terms of actions which are carried out by or on the entities as a whole - the person, the telephone. We don't normally phone a person just for the sake of using the phone. This brings us to the top level and this gives meaning to the action of using the phone. At this top level we talk about what we are trying to achieve by using the phone - exchanging information, for example.
Now what are the differences between the three levels? At the first level we are concerned with technological features, with components that do not stand alone. At this level we are concerned with the design of such features or components. At the middle level we are concerned with whole entities rather than components and the actions or tasks they carry out. At the top level we are concerned with the role of the entities rather than their actions or tasks. Tasks are reasonably well defined, even though there may be variants among the components of which they are made. They have little meaning in themselves and are carried out in fulfillment of roles, which give them their meaning. Hart characterized the difference between tasks and roles by stating that tasks could be entered in a diary while roles (he gave the example ‘Love the neighbour’) could not. Hart pointed out that the three levels are irreducible to each other.

At the task level there is similarity between the views of Hart and Gillies, but there are differences between this two. Hart’s lowest level concerns any component of the whole entity. In the case of a software, this means not just the user interface but also other features and facilities. Gillies’ highest level is differentiated from the task level by moving from the single user to the organisation, but Hart’s is differentiated by the addition of meaning or purpose. It is often the case that the organisation does supply the purpose of tasks so that there is indeed a strong correlation between the two top levels, Hart’s top level is not restricted to consideration of organisations. Hart’s taxonomy seems more exhaustive and having less ambiguity.

1.3.2. Usage of expert systems

We know Hart’s taxonomy to understand the usage of expert system using. At the lowest level, we can talk about what we do with parts of the expert system, such as question-answer session, the explanation facility or using the help facility. It is at this level where the features of an expert system becomes important - what type of explanation it gives, which types of reasoning it employs, etc.

At the next level i.e. at the middle level we are not concerned with the components and features of an expert system, but we look it as a whole. We are concerned with the individual users and which tasks the expert system supports. At this level that classification of expert tasks by Stefik [10] is largely relevant: prediction, diagnosis, planning etc. Consideration of features is largely technology centered, or involves only the primary user’s actions at the user
interface, but consideration of tasks involves the primary user's actions within their immediate organisation.

At the least level i.e. at the top level, one is concerned with the role the users play in making use of the expert system and the purposes for which they carry out the tasks that are supported by it. In an attempt to say something about the application of expert systems, Basden [11] provides a list of roles which expert systems might fulfill: consultancy, checklist, program, communication, knowledge refinement, training and demonstration. But, one can observe that this list was ill formed and is confusing, since it focuses on the roles the software plays rather than the roles of the human actors. Some of the lists are true roles, if translated to the perspective of the human user. For example, by 'communication' it was meant for the clarification and spreading of expertise; and by 'consultancy' it was meant for enabling a person to solve a problem by the provision of expert advice. Both these are examples of roles. But by 'program' it was meant that the expert system shell could be used simply as a language in which to write programs and this is not the role: writing a program is a task.

An automated knowledge-based consultation system should be useful for better health care. It might not be feasible to appoint one paediatrician for each rural health centre whereas the proposed system may be operated by a general medical practitioner. This might be the primary benefit of such a system expected to mitigate such expertise, obviously to a restricted sense. Once, this PC-based consultation system is installed at remote health centres, the system is expected to assist the general physicians who are not expert in paediatrics. This system is also expected to assist the general physicians, not expert in paediatrics, working at sub-divisional/district hospitals or engaged in private practice. Sometimes, it may not be possible to install such a PC-based system at different rural health centres. In that situation, the system may be carried with a mobile medical unit having a personal computer (PC) along with the required power supply. This mobile medical unit may, at least, be controlled by a general physician. Point to mention here, that medical students work with the expert guidance at various fields during their undergraduate/training courses. When posted at a rural health centre, this system should certainly work as a companion of theirs. Even, the system may act as the second opinion.
As they are the scarce commodity, paediatricians are overloaded sometimes. This overloading problem is expected to be reduced to some extent by the use of this automated system. It may also be used as a training kit by the medical students. In all such situations, one may observe the increase of the level of accuracy and confidence during an interaction with a child under treatment. We also certainly expect a better patient management and treatment planning. It is now easy to observe the tangible benefits of the society as well as of rural people. In most of the situations, the rural people need not come to distant-located hospitals, which should save time, money and harassment. Moreover, web-accessible form of the systems, we developed, may be useful at this telemedicine/cyber medicine era.

It is evident from the above discussions, that the common users of the system would be the medical professionals who may not have any exposure to AI and expert systems technology. Even, they might not have any advanced training on computers and computations. Introductory ideas on computers and computations at the school levels would be suffice. Medical curriculum also introduced some advanced concept of Internet surfing and WWW. So, a two days training covering the basics of computers and computations; what is AI and expert systems technology - the usefulness and limitations of this modern technology; and lastly, an overview of the present system would be sufficient. In the initial phase of such use, an easy developer-user interaction should certainly be encouraging to minimise such problems.

Lastly, the reactions of various people in using such a system be analyzed/scrutinized for wider acceptance and use. Various people include: government, doctors, patients, and parents/guardians. Different funding agencies of Govt. of India encourages research projects for the development of such automated systems using AI and expert systems technology under human resource development schemes [12]. Medical professionals are also taking interests in developing and using such automated systems within the confines of the present status of AI and expert systems technology in collaboration with computer professionals. Paediatric patients may not have any adverse impact on this. Rather, they may be attracted by the colourful screen of the computer what may assist a doctor to manage a child during examinations. Parents/guardians are usually guided by the advice from doctors. If the doctors are really motivated in using the system, there should really be no such adverse motivation build-up. Currently, there are good evidences that doctors and biomedical researchers are actively participating with computer professionals in
such projects. Moreover medical professionals are using equipments where the kinds of expert systems are embedded into these equipments.

1.3.3. Benefits of present systems

Basden proposed three levels at which benefits accrue [13]:

a) feature benefits;
b) task benefits;
c) role benefits.

Those advantages that arise from technological features of functionality and user interface are treated as feature benefits. Ease of manipulation can arise, for instance, from graphical user interfaces. An example found in DTI [14] is ‘critical items are highlighted’. The benefits which arise from using the expert system to support a task are task benefits. Examples in DTI [14] include ‘fewer changes to schedule’ and ‘improved visibility of requirements’. Role benefits arise from the effect the expert system has on the roles the user fulfils by carrying out the supported tasks, such as ‘improved supplier relations’, which in DTI [14] is seen to arise from the two task benefits above.

After classifying the benefits into three sets, it is important to have the indication of some form of causal, or at least enabling, link between them. Feature benefits can lead to task level benefits, which can in turn lead to role level benefits as shown in fig.1.3.

![Fig.1.3. Three levels of benefit](image-url)
The role benefits, rather than feature and task benefits, are the determiner of the success or failure of a system. On the contrary, tasks and features find their meaning only in the context of a role. One can now easily view the expected benefits of our proposed system at per the tripartite division: feature benefits, task benefits, and role benefits as shown in fig. 1.4.

From figure 1.4., it is observed that the links are many-to-many rather than one-to-one. Thus, a feature benefit can enhance a number of tasks and a given task may require several feature benefits. Moreover, though there is some causality of the links, while others are merely enabling. Further, there are other factors which influence the operation of each link, such as working practices, organizational norms and attitudes of users or others around them.

Fig. 1.4. The levels of expected benefits in use of our proposed system
1.4. Objective and goals of the study

The objective of this study is to identify the problematic areas of paediatric domain, in-depth analysis, build up roadmap for improvement, finding method to disseminate for the larger audience, develop the medical system thereof, and then determination of specific goals. This study mainly tackles the challenges of (a) Collection, separation, selection of features and their relevance of domain knowledge from vocabulary and database, (b) Identifying approaches for good user acceptance and wide usage of knowledge, and (c) Modeling of Expert Consultation System for better handling of complex and changing requirements.

The specific goals are:

(i) To study the acceptability of medical knowledge available in reputed web-sites.

(ii) To provide, as much as possible, remedies for problems related with content and structure, in particular, to make conscious to the parents/relatives of child patient and advices to consult their physician before apply/administer the same.

(iii) To develop a prototype advisory system to manage febrile child at home, for parents/caregivers, to avoid unnecessary harassment/worry. This would also help indirectly to the society, as it will reduce the painstaking traffic in the community hospital/health centres.

(iv) Proposes methods for management and development of consultation system by selecting of features and their relevancy related to the context of child resuscitation management.

The aim of the present work is to develop a knowledge-based consultation system for paediatric health care management. This we intend to do in steps. We initially have tried to explore the status of the domain which helped us in understanding the needs of the domain. To meet up the needs of the domain, at least partially, an attempt has been made to develop an expert or knowledge based consultation system. Emphasis has been given on different potential issues connected to an expert system development. These issues are (i) knowledge acquisition and representation (ii) uncertainty management (iii) expert system tool selection (iv) user interface (v) performance evaluation and (vi) usage and benefits. Emphasis has also been given on ICT-enabled web
services to medical informatics that in addition to stand-alone system one can access globally. Merits and demerits of cyber healthcare systems were also our concern.

The process of building an expert system is inherently experimental [15]. The applicability of different potential issues pointed out above has been studied in different steps of the development following the prototyping approach of system development. Moreover, expert system development is the first and foremost software engineering [16] and therefore, there has been an attempt in the study to consider some software engineering issues during the development (e. g. phase refinement vs. prototyping).

1.5. Summary of the work

The scheme of presentation is as follows:

A. Chapter 2 of this thesis contains a discussion about medical domain and its characteristics. This chapter also included the statistical importance of different indcitors including mortality and morbidity of the paediatric domain. There has been an attempt to include global as well as Indian scenario.

B. Chapter 3 presents a comprehensive study on Medical Informatics and Cyber Health Care. The usefulness of Artificial Intelligence in Medicine (AIM) and its application through Internet has been discussed. The significance and necessity of ICT-enabled medical services like Telemedicine, their potentiality into health care is presented. We have presented the importance of Cyber Health Care, its future aspects and the issue of Doctor-Patient Relation in the current context.

C. Chapter 4 contains two important issues: (i) why it is an expert system domain; and (ii) what requirements the domain lays on an expert system. This chapter initially discusses, in brief, what is artificial intelligence and expert systems, categories and application areas of expert systems, components of a typical expert system, general desirable features of an expert system, different stages of an expert system development, rule based vs. model based system etc. and lastly, the above mentioned two important issues (i) and (ii) have been presented.
D. In chapter 5, we have presented two issues (i) knowledge acquisition and (ii) knowledge representation. Under the first issue, levels of knowledge and knowledge categories have been discussed. Next, we have explored different sources of knowledge acquisition - their merits and demerits. Here we have also pointed out the prime sources of knowledge acquisition used in the current research. Under the second issue, we have discussed different schemes for knowledge representation and their behaviors. We have also discussed the relative appropriateness of the methods in context to the present problem domain.

E. Chapter 6 deals with the issue of selection of an appropriate expert system tool. A detailed study has been provided here among three types of tools: Al-languages, tool kits and shells.

F. Chapter 7 deals with the issue of uncertainty management. The sources and nature of inexactness have been identified and discussed with examples. A suitability analysis of different methods of handling inexactness which seem(s) to be most sympathetic to the present problem domain has been provided.

G. Chapter 8 presents a comprehensive study of the web-sources on the basis of published guidelines to parents for managing fever at home. We also judged the accuracy, quality, completeness, and consistency of some medical sites and suggest parents/medical help seeker to careful before applying the same in actual practice.

H. In chapter 9, we have presented the Web-accessible consultation systems of Child Fever Management. Initially, the benefits of using expert systems through the Internet have been discussed. Next, the technological artifacts for transference of stand-alone PC-based consultation systems to Web-accessible consultation systems have been discussed. The implementation details and the performance evaluation have been placed. One can visit the Web-site: http://samantark.tripod.com/homepage.html for accessing our systems.

I. In chapter 10, we present a useful technique of developing knowledge-based systems for Neonatal Resuscitation Management using Case-Based Reasoning. This includes design and implementation of a case-based classifier approach. Performance evaluation has been presented taking cases from practitioner's floor.
References


