CHAPTER 1

INTRODUCTION

1.1 MOTIVATIONS AND GOALS

The state of health of a population is a direct determinant of its development. It affects productivity, the potential of children, infant and general mortality, and the allocation of resources within a family, community and nation. Access to better health services helps in poverty reduction and increased productivity. Investment in health is a prerequisite to economic and social progress.

Many developing countries do not have adequate health care and medical services to speak of. Developing countries suffer from a shortage of doctors and other health care professionals. The inadequate infrastructures consisting of roads and transport make it even more difficult to provide the needed health care in remote and rural areas and for the transport of patients properly.

Developing countries face various problems in the provision of medical services and health care, including funds, expertise, resources, which lead to the lack of facilities and systems. For countries with limited medical expertise and resources, communication technologies such as Internet have the potential to provide a solution to some of these
problems. Telemedicine services have the potential to improve both the quality of and access to health care regardless of geography.

They enable access to health care and expertise for under-served locations and also enhance efficiency of health care professionals. Telemedicine facilitates emergency medical assistance, long distance consultation, administration and logistics, supervision and quality assurance and education and training for health-care professionals and providers. It can help in combating tropical diseases and meeting the specific requirements of dermatology, traumatology and many other medical specialties. In the developed countries, there has been a rapidly growing interest in telemedicine and telehealth as a means to ease the pressure of health care on national budgets.

1.2 TELEMEDICINE

Telemedicine can be defined as the distant delivery of health care and remote sharing of medical knowledge using telecommunication means. It aims at providing expert medical care to any place and at anytime. The aim of telemedicine is to improve the quality of healthcare and reduce its cost by faster communication of medical information between physicians and patients. The principal advantage of Telemedicine is that, the doctor and the patient need not be at the same place. Telemedicine is seen as a potentially powerful means of improving the quality of health monitoring and promises to offer a cost-saving alternative to some of the current forms of health care delivery.
Telemedicine as a concept was introduced in the early 70's when telephone and fax machines were the first telecommunication devices used. It is becoming increasingly possible due to the confluence of ongoing technical advances in such areas as telecommunications, imaging, multimedia, computers, and information systems. In recent years, several telemedicine applications have been successfully implemented over wired communication technologies like POTS (Plain Old Telephone System), and ISDN (Integrated Services Digital Network). Telemedicine applications rely on the telecommunication infrastructure which is often chosen carefully to support such applications. The Internet provides a ubiquitous, standardized system interface at low cost, and hence it can help deliver Telemedicine services to a wider population. Internet technology has proved to be a successful tool for the management of patients with multiple medical ailments.

The adoption of the Internet technology has led to new e-Health applications in health care provision. Medical services can now be delivered to any location. Telemedicine has changed healthcare delivery dynamics in the interest of extending health services to all individuals and eliminating time and distance barriers.

Telemedicine is delivering healthcare services to the remotest locations with the use of information and communication technologies. It is exchanging medical information amongst physicians and patients in remote locations with the help of technologies like Local Area Networks, ISDN (Integrated Services Digital Network) and VSAT (Very Small Aperture Terminal), Virtual Private Networks.
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**Telemedicine works over two types of technology concepts**

- **Real time/two-way interactive technology** – also called synchronous telemedicine, where an interactive consultation between doctor and patient takes place in real-time using video conferencing equipment. However, other peripheral devices (like electronic stethoscope or tele-otoscope) can also be attached to the entire setup to aid the interactive patient examination. This method has been successfully used in internal medicine, psychiatry, cardiology, pediatrics, obstetrics and gynecology, and neurology, to name a few.

- **Store and forward technology** – also called asynchronous telemedicine, typically involves transfer of medical data (like x-ray images, ECG signals etc.) to a doctor at a different location for diagnosis or consultation offline. This method is commonly used in radiology, pathology and dermatology.

**Telemedicine has two business perspectives**

- Social perspective - to extend health services in rural and remote areas.
- Commercial perspective –to use as a marketing outpost especially for private sector healthcare providers
Trends

Currently, telemedicine is being used for various reasons such as e-consultation – for Cardiology, Gynecology, Pediatrics, and other vital parameters, remote monitoring of critically ill patients in homecare or hospital set-ups and e-Education in medical sciences.

Technological Advancements/trends

The key focus of advanced technologies in telemedicine is to create an easy user interface for the patients at the point-of-care. With the introduction of advanced monitoring devices in the market patient monitoring at a remote location is getting easier at both the physicians' and patients' end.

Healthcare providers are setting up wireless networks to enable physicians and nurses to share and access critical patient information over the network without being present at the actual point-of-care, helping in faster information flow leading to quick decision-making and improved patient care.

Telemedicine in India

- Telemedicine started in India in the year 2000 with Apollo's Aragonda project in Andhra Pradesh.
- There are around 400 telemedicine centers across India and approximately 50 specialty hospitals are linked to these. Apart from this there are around 100 tele-ECG centers supported by various specialty hospitals.
• An estimated 0.15 million patients have been provided online consultation by various Government and private telemedicine centers.

• Around 4000 patients have been thrombolised by telecardiology services.

In the future, telemedicine applications will use 'unified communications', which means all disparate communication systems like audio, video, web-access and data would be integrated into one stand-alone monitoring system.

There have been a lot of advancements in patient care in home, hospital and mobile environments as well. For home care services there are home monitoring solutions for patient's vital parameters. More compact versions of these solutions are the wireless home monitoring devices, which can be used by patients at home, office or while in transit.

There are plenty of new innovative technologies that help fill gaps in the processes like CPOE (Computerized Physician Order Entry) and e-Prescribing, which makes the process of patient care much easier for physicians and nurses.

A CPOE application substitutes physical medical records with an electronic template where the physicians can issue orders for therapy and procedures electronically, saving time in patient care. These advanced technologies are helping in extending fast and to-the-point healthcare services and also enhancing the productivity and efficiency of healthcare providers.
Growth drivers

The key drivers for Telemedicine projects are:

- **Huge rural population** - With almost 70 percent of India's population living in rural areas and 90-95 percent tertiary health centers located in metros/mini-metros, there is an enormous need for telemedicine projects, to reach out the remotest of areas with healthcare services.

- **The Time-lag factor** - The time-lag between the occurrence of medical need and delivery of the medical services, makes the requirement of Telemedicine facilities even more imperative.

- **Cost Effectiveness** – With the increasing cost of healthcare services, telemedicine is an effective way for providing cost effective care services by saving on travel and time.

- **Technological Innovations** – new technological innovations are providing easy-to-use devices and applications thus reducing the call-for-expertise to operate and manage these devices.

- **Breaking Geographical Boundaries** – telemedicine set-ups have broken distance barriers and have helped healthcare services to extend outreach to remote locations.

- **Knowledge enhancement** – telemedicine will give opportunity for remote doctors to enhance their clinical knowledge over a period of time by having expert opinion for patients.
Challenges

- Some challenges faced by the telemedicine service providers are:
  - Technology integration, that is, successful interfacing of medical equipment and networking
  - hardware and software, satellite connections etc.
  - Difficulties in achieving the last mile connectivity
  - Availability of skilled manpower resources (both medical and non-medical) at remote locations
  - Data protection and security issues
  - Cost-benefits of the project and of course the adequate patient traffic at the remote centers

Telemedicine and its Uses

- Teleconsultation – real time consultation with patients in presence of remote doctors for various specialties like pediatrics, gynecology, neurology, cardiology, etc.
- Teleradiology and Telepathology – consultation and reports for radiology services and pathology tests conducted at remote locations.
- Telecardiology – online consultation, real time ECG transfer
- e-ICU – real-time monitoring of remote ICU through multi-parameter monitors
- Tele-Asthma – monitoring Pulmonary functions remotely and providing consultation based on results.
- Tele-Psychiatry – providing psychiatric counseling and consultation by experts through video conferencing
• Tele-Dermatology – providing diagnosis and consultation based on images of patient's ailments

Work done so far

In India, many Government and private hospitals have taken initiatives for implementing telemedicine projects.

Indian Space Research Organization – pioneer in conceptualizing and implementing telemedicine projects across the country in private and government organizations. ISRO has been providing VSAT connectivity, hardware, software and telemedicine services to various organizations. It has also started setting up Tele-health / Tele-education facilities at Village Resource Centers across India to increase the outreach to more number of rural villages.

Some major Telemedicine programs are also being run by the following organizations:

All India Institute of Medical Sciences (New Delhi), Apollo Hospitals (Hyderabad), Aravind Eye Hospital (Madurai), Army Hospitals, Fortis Healthcare (Delhi), KLES Hospital (Belgaum), L. V. Prasad Eye Institute (Hyderabad), Manipal Health Systems (Bangalore), Max Healthcare (Delhi), Narayana Hrudayalaya (Bangalore), Navy Hospitals, PGI (Chandigarh), Sankara Nethralaya (Chennai), SGPGI (Lucknow), Space Hospitals (Chennai), SRMC (Chennai), Tata Memorial Hospital (Mumbai).

State Government Telemedicine projects have been implemented by the following states:
Karnataka, Tamil Nadu, Madhya Pradesh, Chhatisgarh, Rajasthan, Jammu and Kashmir, Pondicherry, Kerala, Gujarat, West Bengal, and the north eastern states, etc.

Opportunities identified for reduction of health care costs without compromising quality, effectiveness, accessibility.

1.3 DIABETES AND ITS SOCIOECONOMIC CONSEQUENCES

Diabetes is a damaging disease that almost all organs of the body. It not only impacts lifestyle, it can also cause serious health complications. It is a major risk factor for heart disease, stroke, kidney failure, adult blindness and amputations. If diabetes is managed effectively, these complications can be eliminated. Some of diabetes related complications are coronary artery disease, peripheral vascular disease, neuropathy, retinopathy, and nephropathy. Patients with diabetes are 25 times more likely to develop blindness, 17 times more likely to develop kidney problems, 30-40 times more likely to need amputation, 2-4 times more likely to develop myocardial infarction and twice likely to develop stroke than a non-diabetic. Thus a lifestyle modification inclusive of dietary modification, regular physical activity and weight reduction are necessary for prevention of diabetes. The objective of this Web based healthcare solution is to establish an intelligent health care kiosk, leveraging advanced computer technologies to enable delivery of health care services to the individual or a community through the Internet.

1.4 CONVENTIONAL METHODS OF PATIENT MONITORING

Diabetes is a chronic disease characterized by a sustained elevated blood glucose level, caused by a reduction in the action of insulin secretion wherein related metabolic disturbances generate severe, acute and long-term complications that
are responsible for premature death and disability. To obtain the best care outcomes, diabetes patients should receive medical care from a physician-coordinated team. Such teams may include physicians, nurses, dieticians, pharmacists and mental health professionals with expertise and interest in diabetes. This collaborative and integrated shared care approach requires that individuals with diabetes assume an active role in their care.

Glycemic control is fundamental to the management of diabetes. The benefits of the intensive insulin therapy have been well established, demonstrating the reduction in long-term complications. Nowadays it is possible for that a well-treated diabetes patient to expect to have an almost normal life span although the achievement of the therapeutic goals requires a tight control of patients in their self monitoring blood glucose levels and day-to-day insulin adjustment, requiring in many cases a better patient empowerment and education. Nevertheless, the fulfillment of the current guidelines in diabetes management implies a significant increase in the amount of patient data to be monitored, increasing physicians and workload for nurses raising immediate health care costs.

1.5 THE PROPOSED WEB CENTRIC DIABETES DIAGNOSIS TELEMEDICINE SYSTEM

This work proposes a medical network based on state-of-the-art medical kiosk that addresses the problems of providing preventive and diagnostic health care. The patients can directly enter and can be
screened for diabetes with all the necessary tests that are fully automated. The Web centric diabetes expert system runs on a telehealth server and is connected to the kiosk through the WWW. Based on the symptoms, tests taken and previous history of the patient, a prescription is generated by the expert system that is sent to a hospital where the doctor is online. Any changes required can be made by the physician in the diagnosis and prescription generated by the expert system and sent to the patient at the kiosk end as a printout. A Web-based telehealth system employs expert system rules to detect different kind diabetes and diabetes related diseases. The types of diabetes that can be detected with this system are type1, type2 and gestational diabetes.

This research is designed in UML and programmed via the dot net framework. The expert rules were developed based on the symptoms of each type of diabetes. The decision support system developed in this work is able to detect and give early diagnosis of three types of diabetes namely type 1,2, gestational diabetes for both adults and children.

The telehealth care diabetes diagnosis solution is an intelligent health care environment that aims to ensure lifelong coverage of patient specific health maintenance decision support service using WWW. The functionality of telehealth care diabetes solution involves (a) generation and delivery of diagnosis and treatment of diabetes and diabetes related diseases (b) remote diagnostic services through the kiosk. It is an amalgamation of diverse computer technologies such as artificial intelligence, Internet, multimedia, databases and medical informatics to implement a sophisticated telehealth care delivery model.