CHAPTER 3

Medical Informatics and Cyber Health Care†

3.1. Introduction

If the physiology literally means the ‘logic of life’, and pathology is the ‘logic of disease’, then medical informatics is the logic of health care [1]. It is the study of the way, we think about patients, and the way the treatments are undertaken. It is study of how the medical knowledge is created, analysed and are shared among professionals and applied to the medical domain. Ultimately, it is the study of how we can establish proper health care management.

Although the term ‘medical informatics’ (MI) appeared in the literature in around 1973, but the study is as old as when a doctor examined a patient, first recorded the findings and later used those information to his/her next patient. Medical informatics is as much about computers as cardiology is about stethoscopes. The field of medical informatics is concerned with computers, communications, doctors, patients, nurses and medical knowledge.

The interests, role and applications of information sciences in medicine are growing exponentially this decade, the Internet decade, compared to the last decade of Eighties. Not only the patient records are being stored and retrieved but it covers everything from the manner in which evidence is used in clinical decisions, how one decides which piece of knowledge is relevant to a particular situation, and ultimately to how medical knowledge itself is created. Another dimension has been added with the introduction of World Wide Web (www) and Internet services. It has resulted some new techniques, concepts and ideas (e.g. telemedicine).

Summarily, medical informatics use more or less all methods of information technology such as acquisition, processing, control, interpretation, transformation, transfer and presentation of data for medical purpose. Networking of large health care groups, linking of hospitals and research centers, transfer of diagnostic and therapeutic information, video conferencing,

application of hospital information system, expert systems for diagnosis, image analysis and pattern recognition for pathological investigations, telediagnosis and telemedicine, virtual reality training for surgical applications and modelling of brain for psychophysiological and individual animations will be useful and integral part of biomedical technology in the 21st century.

Medical informatics is an interdisciplinary biomedical scientific and engineering field providing theoretical methods and applied tools for the support and optimization of medical discovery, medical education, clinical practice and health care organization. It is located at the intersection of information technology and the different disciplines of medicine and health care. Therefore the domain of medical informatics is determined by the intersection of the terms "medicine" and informatics". The first term indicates the area of research while the second one its methodology. Scientific research in medical informatics is multidisciplinary and follows scientific methods. It is the study and use of computers and information in health care purpose for patient care, research, medical education, combination of and interfaces between several disciplines not just computers but information in general to provide better health care. The discipline has a thirty-year history that provides a frame as reference for a definitions suggested by researchers and practitioners might be useful here for understanding the features and functionalities of medical informatics as follows:

'Medical Informatics is the rapidly developing scientific field that deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge for problem solving and decision making' [2].

'Medical informatics is the application of computers, communications and information technology and systems to all fields of medicine - medical care, medical education and medical research' [3].

3.2. Focus of medical informatics applications

Medical informatics became increasingly recognized as an important component of the overall practice of medicine. The development of advanced Medical Informatics has obtained a multi-dimensional content.

Hence the focuses of Medical Informatics are grand challenges to all scientist, researchers, computer professionals, medical professionals and associated personnel. The following are the major areas of medical informatics applications.
Table 3.1. Areas of medical informatics applications [4].

- Medical Information Standards
- Medical Informatics Training
- Medical Education and Integrated Academic Information Management Systems (IAIMS)
- Computerized Medical Records
- Clinical Information Systems (including radiology, laboratory, pharmacy, nursing, etc.)
- Organization of Heath Services (Preventive intervention, cost-effectiveness analyses etc.)
- Physician Order Entry Systems
- Computer-Aided Instruction
- Medical Expert Systems
- Nursing Informatics
- Announcements of Interest, e.g. conferences, journals, societies
- National Library of Medicine
- Health Information Networks
- Medical Software Reviews
- Research Funding Opportunities
- Policy Making on Medical Software (procurement, certification etc.)
- Medical Software Engineering
- Cultural/Sociologic Changes
- Medical Software Security
- Telemedicine
- Veterinary Informatics

Now medical informatics has gained a multidimensional content and utilizes methods from many sciences viz. Information Science, Computer Science, Biomedical Technology, Business Organization and Administration, Cognitive Science, Statistics, Mathematics, Artificial Intelligence, Operations Research, Economics etc. Medical Informatics therefore has a content of basic research, clinical medicine and organization of health services. During the last years it has surpassed the narrow limits of planning and implementing information systems and it now constitutes an integrated, analytical, rational approach to medical research and practice.
3.3. Medical informatics and health care professional

Medical Informatics has both theoretical and applied aspects. Health care systems will face difficult challenges with the emergence of novel MI applications. Physicians should be prepared to carefully adopt technologies which are effective for their use. Thus every physician and health care professional should have knowledge of the following basic skills:

- Basic knowledge of elements of computer operation, applications and computer network organization and their use.
- To understand the operating system platform of the technology.
- Basic knowledge of research design, biostatistics, and the process of medical research and publication. Also knowledge of library organization, ability to use the MEDLINE system in order to find medical references.
- Capability to differentiate the ethical and societal issues related with MI.
- Ability to use the Internet to find medical information and ability to evaluate the reliability and completeness of information and resulting data.
- Knowledge of basic principles of Medical Decision Making Theory.
- Capability to interaction with web-based medical applications.
- Knowledge of basic cognitive biases and errors during treatment plan, diagnosis and therapy.
- Aptitude in written communication using a plain, clear, distinct and easily understood language.

3.4. Landmarks of medical informatics applications

The remarkable publication of by Lendley and Lusted during 1950-60s was the process of medical diagnosis and treatment using computer. The first applications of a computer for diagnosis of congenital heart diseases were described by Warner and associates. The two significant medical information systems (i) Reminder Systems for hospitals and (ii) MEDLINE system for physicians' offices has been developed and implemented during 1970s. Using symbolic artificial intelligence, a system has developed called INTERNIST, used for diagnoses general internal medicine with equal or even greater accuracy than specialized physicians. Between 1980s and mid 1990s has great contribution to the development of medical informatics involving of applications of medical decision making theory and introduction of Bayes' networks. From this time, medical informatics is widely established as an independent biomedical branch and included as advanced programs of formal education. From middle of 1990s, the enormous success of the World Wide Web to a large
degree and explosive development of specialist software applications changed the picture. From then, varieties of modern technologies are being applied and huge medical applications and services are being introduced and offered, such as:

- Artificial Intelligence in Medicine (AIM)
- Digital Libraries.
- Distributed Internet Data Bases.
- Electronic Trade.
- Internet-based Telephony.
- Intranets.
- Streaming Video and Sound.
- Teleconferencing.
- Tele-education.
- Telemedicine.
- Virtual Reality.
- Cyber Medical Practice

Let us now have a look on the issues (i) Artificial Intelligence in medicine (AIM) (ii) Internet and World-wide-web and (iii) Telemedicine, contributing to the advancement of medical informatics.

3.5. Artificial intelligence in medicine (AIM)

In the year 1984, Clancey and Shortliffe [5] provided the following definition of AIM:

‘Medical artificial intelligence is primarily concerned with the construction of AI programs that perform diagnosis and make therapy recommendations. Unlike medical applications based on other programming methods, such as purely statistical and probabilistic methods, medical AI programs are based on symbolic models of disease entities and their relationship to patient factors and clinical manifestations’.

But, however, these days the above definition would be considered narrow in vision and scope. As per the state of the art AIM has already contributed much more than defined by Clancey and Shortliffe.

AIM systems are by and large intended to support health care workers in the normal course of their duties, assisting with tasks that rely on the manipulation of data and knowledge. An AI system could be running within an electronic medical record system, for example, and alert a clinician when it detects a
contraindication to a planned treatment. It could also alert the clinician when it detected patterns in clinical data that suggested significant changes in a patient's condition.

Expert or knowledge-based systems are the commonest type of AIM system in routine clinical use. They contain medical knowledge, usually about a very specifically defined task, and are able to reason with data from individual patients to come up with reasoned conclusions.

There are many different types of clinical task to which expert systems can be applied:

- **Diagnostic assistance**
  When a patient's case is complex, rare or the person making the diagnosis is simply inexperienced, an expert system can help come up with likely diagnoses based on patient data.

- **Therapy critiquing and planning**
  Systems can either look for inconsistencies, errors and omissions in an existing treatment plan, or can be used to formulate a treatment based upon a patient's specific condition and accepted treatment guidelines.

- **Generating alerts and reminders**
  In so-called real-time situations, an expert system attached to a monitor can warn of changes in a patient's condition. In less acute circumstances, it might scan laboratory test results or drug orders and send reminders or warnings through an e-mail system.

- **Agents for information retrieval**
  Software 'agents' can be sent to search for and retrieve information, for example on the Internet that is considered relevant to a particular problem. The agent contains knowledge about its user's preferences and needs, and may also need to have medical knowledge to be able to assess the importance and utility of what it finds.

- **Image recognition and interpretation**
  Many medical images can now be automatically interpreted, from simple X-rays through to more complex images like angiograms, CT and MRI scans. This is of value in mass-screenings, for example, when the system can flag potentially abnormal images for detailed human attention.
Although, some of us had a question in mind whether the AI systems should come in clinical use or not? Now, today, there is good evidence that expert systems are working well (table 4.4 in chapter 4) as routine clinical use. Efforts are needed to increase the number of such systems.

3.6. Internet and World-Wide-Web applications

The Internet is the largest global network of computers and the most important force for the development of telematics and telemedicine. It is an open and unregulated community of people who communicate freely across an international electronic computer network. It connects personal computers, local area networks, metropolitan networks and wide area networks (national, continental) belonging to universities, organisations, governments, and private citizens from all over the world.

It is estimated that, in 2008, more than 1463 million users are connected to Internet worldwide, where 60 million are from India, 253 million from China and 220 million belongs to USA. The latest data of global Internet penetration, user growth as well as for top 20 countries can be seen from the table 9.3 of chapter 9 of this thesis.

For a long time, users communicated on the internet using electronic mail. This essentially allowed users to exchange text messages across the globe, usually in a matter of minutes. Apart from electronic mail, some basic applications (i) sending and receiving of files (FTP), (ii) remote login (iii) newsgroups (iv) data services based on menus (Gopher), (v) data services based on searching with key-words (WAIS) are also available. However, it was probably the advent of the World Wide Web that triggered the recent growth of the internet. Essentially a set of software standards, Web programs allow users to navigate rapidly across the global internet. Here they can view a bewildering variety of information, from the bizarre and inaccurate, to the most up-to-date information available from scientific bodies, newspapers and academic journals.

Perhaps just as important as the ability to view information, the web provides methods for anyone to publish information, and make it immediately available across the globe. This is achieved through a simple set of document standards that allow users to create electronic documents using text, image and video. The quality of these documents is now so high that the Web is used, for example, by several medical educational institutions. But, however, there are some problems with quality and other related issues have been discussed in chapter 8.
3.7. Telemedicine

The essence of telemedicine is the exchange of information at a distance, whether that information is voice, an image, elements of a medical record, or commands to a surgical robot. It seems reasonable to think of telemedicine as the communication of information to facilitate clinical care. The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of information at a distance, whether that information is voice, an image, elements of a medical record, or commands to a surgical robot. It seems reasonable to think of telemedicine as the communication of information to facilitate clinical care including diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities [6].

Telemedicine is the ability to provide interactive healthcare utilizing modern technology and telecommunications. Basically, Telemedicine allows patients to visit with physicians live over video for immediate care or capture video/still images and patient data are stored and sent to physicians for diagnosis and follow-up treatment at a later time. It is an invaluable tool in Healthcare.

At its inception telemedicine was essentially about providing communication links between medical experts in remote locations. The health care system, however, is clearly inefficient because of its poor communication infrastructure and telemedicine is now seen as a critical way of reducing that cost. One estimate suggests that the health system in the United States could save $30 billion a year with improved telecommunications [7].

Table 3.2. Some leading telemedicine international healthcare providers.

<table>
<thead>
<tr>
<th>Telemedicine healthcare providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Health Edmonton, Canada, <a href="http://www.capitalhealth.ca">www.capitalhealth.ca</a></td>
</tr>
<tr>
<td>Treatment Patient Self-Care, Canada, <a href="http://www.treatment.com">www.treatment.com</a></td>
</tr>
<tr>
<td>Vancouver Island Health Authority, Canada, <a href="http://www.viha.ca">www.viha.ca</a></td>
</tr>
<tr>
<td>Latin Telecomunicaciones S.A., Chile, <a href="http://www.latintele.com">www.latintele.com</a></td>
</tr>
<tr>
<td>Universidad Icesi, Comobdia, <a href="http://www.icesi.edu.co">www.icesi.edu.co</a></td>
</tr>
<tr>
<td>Centro Nacional de Excelencia Tecnológica en Salud, Mexico,</td>
</tr>
<tr>
<td><a href="http://www.cenetec.salud.gob.mx">www.cenetec.salud.gob.mx</a></td>
</tr>
<tr>
<td>Access Psychiatry, USA, <a href="http://www.accesspsych.org">www.accesspsych.org</a></td>
</tr>
<tr>
<td>Institution Name</td>
</tr>
<tr>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>Akron Children’s Hospital, USA</td>
</tr>
<tr>
<td>Arizona Telemedicine Program’s Training Center, USA</td>
</tr>
<tr>
<td>Brighton Int’l University, USA</td>
</tr>
<tr>
<td>Carol M. Stock &amp; Associates, USA</td>
</tr>
<tr>
<td>Cedars-Sinai Medical Center, USA</td>
</tr>
<tr>
<td>Christus Health, <a href="http://www.christushealth.org">www.christushealth.org</a></td>
</tr>
<tr>
<td>Cnow Telehealth Solutions, USA</td>
</tr>
<tr>
<td>Colorado Neurological Institute, USA</td>
</tr>
<tr>
<td>Council of Community Clinics, USA</td>
</tr>
<tr>
<td>CTEC - California Telemedicine &amp; eHealth Center, USA</td>
</tr>
<tr>
<td>Doctors on Demand Health Networks, USA</td>
</tr>
<tr>
<td>Driscoll Children’s Craniofacial &amp; Cleft Center</td>
</tr>
<tr>
<td>The Geneva Foundation Telemedicine &amp; Advanced Technology Research Center, USA</td>
</tr>
<tr>
<td>Gunderson Lutheran, <a href="http://www.gundluth.org">www.gundluth.org</a></td>
</tr>
<tr>
<td>Honolulu Shriners Hospital, USA</td>
</tr>
<tr>
<td>John Hopkins University, USA</td>
</tr>
<tr>
<td>John Muir Health, USA</td>
</tr>
<tr>
<td>Linder Psychiatric Group, Inc., USA</td>
</tr>
<tr>
<td>Matria Healthcare, <a href="http://www.matria.com">www.matria.com</a></td>
</tr>
<tr>
<td>North Neck Middle Peninsula Telemedicine, USA</td>
</tr>
<tr>
<td>rchn Community Health Foundation, USA</td>
</tr>
<tr>
<td>Sacred Heart Medical Center, USA</td>
</tr>
<tr>
<td>Saint Louis University, USA</td>
</tr>
<tr>
<td>Shriners Hospitals for Children Telemedicine Initiative, USA</td>
</tr>
<tr>
<td>Shriners Hospitals Cincinnati Pediatric Specialty Care, USA</td>
</tr>
<tr>
<td>Telepeds, USA</td>
</tr>
<tr>
<td>Texas Tech University Center for Telemedicine, USA</td>
</tr>
<tr>
<td>University of Arkansas for Medical Sciences - Center for Distance Health, USA</td>
</tr>
<tr>
<td>University of California, Davis, USA</td>
</tr>
<tr>
<td>University of New Mexico Health Sciences Center, USA</td>
</tr>
<tr>
<td>University of Pittsburgh Medical Center, USA</td>
</tr>
<tr>
<td>University of Pittsburgh School of Health and Rehabilitation Sciences, USA</td>
</tr>
<tr>
<td>WorkCare, USA</td>
</tr>
<tr>
<td>S.O.S. Telemedicina, Instituto de Medicina Tropical, VENEZUELA</td>
</tr>
</tbody>
</table>
3.7.1. Advantages of telemedicine

In a telemedicine setup the main stakeholders are of three types: (i) physicians at referral centre or spoke-site, (ii) patient including community and (iii) Physicians at nodal centre or the hub site. The common benefits of these stakeholders are:

- Improved recipient access to health care services;
- Improved recipient compliance with treatment plans;
- Medical services rendered at an earlier stage of disease, thereby improving long term patient outcomes;
- Reduced costs for covered services such as hospitalizations and transportation.
- To jointly deliver clinical care for and remote diagnostic on patients;
- In live, interactive & collaborative surgery broadcast;
- To conduct real-time, collaborative medical seminar and training for medical students, doctors and related healthcare professionals;
- To share electronic medical records and information of patients either on-line or off-line.

Additionally, each stakeholder has their own benefits like:

Physicians at referral centre or spoke site:
- Receive education from the specialist/provider
- Better health outcome for their patients
- Enhanced community confidence in local healthcare
- Attend continuing medical education courses from their health center

Patient including community
- Loved ones remain in their community with family support and Funds follow the patient
- Cost savings from not having to travel extensively
- Immediate urgent care
- Confidentiality of specialty examination or visit (Because the patient visits the general practice doctor, can be seen for any specialty care without anyone else knowing)
- Patient educations courses (nutrition, oncology etc.)
- Properly stabilize patient prior to transport
- Early Diagnosis prior to escalated medical episode
Physicians at nodal centre or hub site

- Expand patient outreach
- Major surgical procedures resulting from the initial telemedicine consultation
- Reduction in ER visits
- Promotion of Hospital
- Charge tuition for clinician education courses

3.7.2. Telemedicine Usage Models

3.7.2.1. Real-time

This is the most common use in Telemedicine. Here, live video allows the provider, patient and specialist to all communicate together to achieve the best outcome for the patient. Immediate specialty consultation can be available for inpatient/outpatient through this method. Generally this requires high bandwidths for communication and transmission.

3.7.2.2. Store and forward

This gradual and comparatively cheaper method used when both health providers are not available or not required at the same time. The provider’s voice or text dictations on the patient’s history, current affliction including pictures and/or video, radiology images, etc., are attached for diagnosis. This record is either emailed or placed on a server for the specialist’s access. The specialist then follows up with his diagnosis and treatment plan.

3.7.2.3. Home health telemedicine

Home health allows the remote observation and care of a patient. In the event of post-operational case, a patient required general observation after a surgery or other medical procedure, the home health telemedicine is usually valuable. The patient would be more comfortable to get post-hospital care at home rather than in a hospital bed. Home health equipment consists of vital signs capture, video conferencing capabilities, and patient statistics can be reviewed and alarms can be set from the hospital nurse’s station, depending on the specific home health device. Generally this method is used for assisted living, disease management of unmovable patient etc.
3.7.3. System requirements

A telemedicine system has a unique set of requirements which distinguishes itself from a normal teleconferencing system in many respects. The ultrasound study consisting of images, color flow, and Doppler spectral and auditory information of good quality needs to be transmitted in real time. Many image processing and graphics functions are often necessary when analyzing medical images to make a primary diagnosis or plan a treatment. To meet the clinical requirements of a telemedicine system, it must be fast, reliable, easy to use, and provide excellent image quality. From the above-mentioned state of affairs, the requirements can be categories as follows:

Hardware requirements for referral and nodal centers
- two Pentium server having at least 2GB RAM and 360 GB HDD withk keyboard, mouse and LCD color monitor
- Multimedia Kit

Software requirements for referral and nodal centers
- Operating System - Windows 2000 Professional or Windows XP or above
- Database- SQL Server 2000

Peripheral devices at nodal centers
- X Ray Scanner, Digital camera
- Microscope with CCD camera with image grabber card supporting JPEG and BMP image formats
- ECG Recorder, View Box
- Laser printer
- 2/5/10 KVA On-Line UPS

Networking requirement (any one)
- Telephone lines and Modems (for normal PSTN Connection)
- ISDN lines, Router, NT1 (for ISDN connection)
- Router, leased line modems (for leased line connection)
- VSAT SkyIP unit
- Wi-MAX CPE
- Fiber Optic CPE

Video conferencing Systems
- Multipoint V.C. systems for referral and point to point systems for Nodal centers
3.7.4. Users requirements

(a) Medical Experts: Top level consultants of respective diseases at referral centers. Specialists doctors may want to directly examine the patient, e.g. they may require to (i) feel pulse, look at skin patches, listen to heart bits etc., (ii) talk with the patients.

(b) General duty medical officers: Available doctors stationed at nodal centers. Doctors should consult among themselves, as they would have done in physical proximity. This implies that they should be able to: (i) see and to listen each other (ii) write text and to draw diagrams, (iii) discuss on pathological test reports, slides, photographs, ECG, EEG etc., (iv) discuss with the operations of different diagnostic tools and devices such as USG machines, microphones etc., and (v) prescribe and advice.

(c) Paramedical staffs: Laboratory technicians and data entry operators. They are responsible for maintenance of patient records and generation of information based on queries related to a single patient, a group of patient, diseases etc.

(d) The direct beneficiaries are the patients who are suffering from diseases and they should have also some knowledge of the functioning of the system.
3.8. Barriers before development of telemedicine

Even though telemedicine offers great hope for improving health care, there are lots of barriers, ranging from logistical to emotional, affect the development of Telemedicine. The table below identifies the key factors affecting development of telemedicine are:
Table 3.3. Factors affecting development of telemedicine [9,10].

<table>
<thead>
<tr>
<th>Infrastructure Planning and Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telecommunications Regulation e.g. broadband availability</td>
</tr>
<tr>
<td>Lack of Reimbursement for Telemedicine Services</td>
</tr>
<tr>
<td>Level of information sharing (spurred by Customer Directed Healthcare)</td>
</tr>
<tr>
<td>Credentials of provider: Licensure and credentialing of physicians and supporting health care staff</td>
</tr>
<tr>
<td>Legislation for change, license</td>
</tr>
<tr>
<td>Shortage of trained staff</td>
</tr>
<tr>
<td>Level of comfort with technology: The sophistication and evolution of sensor technology, reliability, and sensitivity</td>
</tr>
<tr>
<td>How quickly medicare moves to a risk based policy</td>
</tr>
<tr>
<td>Privacy and security issues: Confidentiality of patient-identifiable medical information</td>
</tr>
<tr>
<td>Medical malpractice liability</td>
</tr>
<tr>
<td>Use of true cost/value/outcome measures</td>
</tr>
<tr>
<td>Impact of acceptance: The fact that the patient does not have to see the doctor, make pandemic</td>
</tr>
<tr>
<td>Rate telemedicine is integrated into healthcare educational system</td>
</tr>
<tr>
<td>Private industry support: Could be a retailer, supplier of telemedicine or respond to the burden of healthcare costs</td>
</tr>
<tr>
<td>Clinician's view on effectiveness</td>
</tr>
<tr>
<td>Job security concerns</td>
</tr>
<tr>
<td>Cultural obstacles (resistance to commoditization of services)</td>
</tr>
<tr>
<td>External including political intervention</td>
</tr>
</tbody>
</table>

3.9. Health care scenario of telemedicine in India

The fact is that while 75% of our population lives in rural India; 90% of secondary and tertiary care facilities are in the cities and towns far away from the rural India, more than 75% of Indian doctors are based in cities. Most of the 620 million rural Indians lack access to basic health care facilities [11]. The Indian government spends just 0.9% of gross domestic product (GDP) the country's annual on health, and little of this spending 0.09 per reaches remote rural areas [12]. However there has been an unprecedented growth and development in Information Technology. At the same time, it is also a fact that a significant proportion of patients in these remote locations could be successfully managed with some advice and guidance from specialists and super-specialists in the cities and towns. This is the power of Telemedicine. It is no surprise that
Telemedicine is playing an increasingly important role in not only providing diagnostic and consultation services but also in facilitating Tele-education and training of personnel across the country.

With the help of INSAT-3B and INSAT-3A launched in the years 2000 and 2003 respectively by ISRO, telemedicine links have been established in India among different Referral hospitals and Speciality hospitals. Starting with Karnataka/NER Network (5 nodes) early in 2001, the connectivity has been provided for more than 34 nodes with 26 patient ends and 8 super-speciality ends in the country, and telemedicine networks are operational for Karnataka/NER, Andaman & Nicobar, Ladakh, Tamilnadu, Orissa, Kerala, Lakshadwweep, Sikkim, West Bengal etc.

During the year 2004 [13], 23 additional hospitals were brought into the telemedicine network bringing the total number of hospitals in the network to 50 hospitals - 36 Remote/District/Medical/Mobile Hospitals connected to 14 Super Speciality Hospitals as follows.

- 4 Islands of Lakshadweep, (Amini, Agatti, Andrott and Minicoy) connected to Amritha Institute of Medical Sciences, Kochi.
- 5 Remote/field/base hospitals for Indian army connected to research and referral hospital at New Delhi.
- STNM Hospital Gangtok, Sikkim and Regional Institute of Medical Sciences, Imphal, Manipur connected to Asia Heart Foundation, Kolkata.
- Mobile Tele-ophthalmology Unit for the Eye Care Camps with connectivity to Shankara Netralaya, Chennai and Bangalore.
- Tata Memorial Cancer Centre connected to the Remote Cancer Centre at B B Barua Cancer Centre, Guwahati.

During the year 2005 [14], the telemedicine network has been further expanded and it now covers 100 hospitals - 78 remote/rural/district hospitals/ health centre connected to 22 super speciality hospitals located in the major cities as follows:

- Nine hospitals in Jammu and Kashmir, six district hospitals including Leh and Kargil and three medical college hospitals connected to All India Institute of Medical Sciences, Delhi, Apollo Hospitals, Delhi and Amritha Institute of Medical Sciences, Kochi.
- Five islands of Lakshadweep (Kavaratti, Amini, Agatti, Andrott and Minicoy) connected to Amritha Institute of Medical Sciences, Kochi.
Five remote/field/base hospitals of Indian Army connected to research and referral (R&R) Hospital at New Delhi. INHS, Dhanvanthri under the Naval Command at Port Blair, Andamans connected to R&R Hospital, New Delhi.

Eleven hospitals of North Eastern states (STNM Hospital Gangtok, Sikkim Regional Institute of Medical Sciences, Imphal, Manipur Medical College Hospital, Guwahati and District Hospital at Udaipur, Tripura) connected to Asia Heart Foundation, Kolkata.

Tata Memorial Cancer Centre, Mumbai connected to B B Barua Cancer Centre, Guwahati and Wal Waker Rural Cancer Centre at Chiplun, Maharashtra.

Three Medical College Hospital of Orissa connected to SGPGI, Lucknow.

Operational telemedicine network in Karnataka - 11 district / taluk hospitals connected to five super speciality hospitals in Bangalore and Mysore.

Besides the above, a temporary telemedicine facility was set up for two months at Pampa at the foothills of Sabarimala shrine for the benefit of visiting pilgrims. A mobile teleophthalmology facility has been provided to Shankara Netralaya, Chennai and Aravind Eye Hospital, Madurai to extend services to rural population in Tamil Nadu.

Operational telemedicine network is being established in Chhattisgarh connecting 14 district hospitals/health centres to Raipur Medical College Hospital.

More than 25,000 patients have so far been provided with teleconsultation and treatment. An impact study conducted on thousand patients has revealed that there is a significant cost saving in the system since the patients avoid expenses towards travel, stay and for treatment at the hospitals in the cities.

The Andaman Telemedicine Network consisting of Telemedicine centres at G.B. Pant Hospital, Port Blair, Bishop Richardson Hospital, Car Nicobar and INHS, Dhanavanthri Naval Hospital at Port Blair alongwith the Andamans Gramsat Network was extensively used for tele-consultation and treatment in the aftermath of the tsunami that hit the island.

During the year 2006 [15], the telemedicine network has been further expanded to cover 152 hospitals - 120 remote/rural/district hospitals/health centres connected to 32 speciality hospitals located in major cities. A mobile health service vehicle 'DISHA' operated by private entrepreneur in the Madhurai District of Tamil Nadu has also been provided telemedicine connectivity.
The Department of Information Technology (DIT) has taken a pivotal role in defining and shaping the future of telemedicine application in India. Backed by a strong vision to build a national telemedicine network in India, DIT has been involved at multiple levels - this includes development of technology, initiation of pilot schemes and standardization of telemedicine in the country, includes the follows [16].

DIT implemented Tele-medicine for diagnosis and monitoring of tropical diseases in School of Tropical Medicine, Kolkata and two district hospitals in West Bengal. Similarly, DIT has funded establishment and subsequently implemented an oncology network for providing telemedicine services in cancer detection, treatment, pain relief, patient follow-up and continuity of care in peripheral hospitals (nodal centers) of Regional Cancer Center (RCC). The project was implemented by C-DAC, Trivandrum and Regional Cancer Center (RCC), Trivandrum.

Table 3.4. Some successful telemedicine projects in India [16].

<table>
<thead>
<tr>
<th>Name of the project</th>
<th>Promoters/sponsors</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPP Through Telemedicine</td>
<td>Andhra Pradesh Vaidya Vidhana Parishad (APVVP), APOLLO Hospitals, CARE Foundation</td>
<td>The State-run APVVP, which manages nearly 200 hospitals in Andhra Pradesh, has launched the Telemedicine project in the month of October 2001 with the collaboration of local private partners. The responsibility of providing the telemedicine-compatible diagnostic medical equipment such C.T. Scan, ultra sound scanner, colour Doppler, ECG, digital x-ray, etc., in the district hospitals.</td>
</tr>
<tr>
<td>Rajkot Civil Hospital</td>
<td>Rajkot Civil Hospital and U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad.</td>
<td>Rajkot Civil Hospital has developed a telemedicine link with U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad. The system can be used to transmit online ECG, CT scans, magnetic resonance imaging, Cathlab reports, pathological reports, doctors' prescriptions, typed and even handwritten notes, and moving images. The important innovation employed in this system is the Event Recorder (ER). The ER has no cords attached to it. The patient simply has to place it on his chest, push a button and wait for a minute for recording the ECG and get converted into electronic signals on the doctor's personal computer.</td>
</tr>
<tr>
<td>Apollo telemedicine</td>
<td>Apollo group</td>
<td>A 50 bed hospital in Aragonda village (population of 15,000) of Chittor district in Andhra Pradesh is connected to the Apollo group main hospitals in Chennai and Hyderabad through a satellite link. The center is equipped with facilities such as an operating theatre, a computed -tomography scanner and software. Doctors the telemedicine center can scan, convert and send data images via satellite link to the tele-consult stations at Hyderabad and Chennai.</td>
</tr>
</tbody>
</table>
Narayana Hrudayalaya, located in Bangalore is developing as a hub for telecardiology networks with a joint venture between the governments of seven hill states, Government of West Bengal, Karnataka Health Systems and ISRO to create a chain of coronary care units in remote areas and offer modern cardiac care infrastructure.

The Pune district administration has teamed up with doctoranywhere.com and Tata Council for Community Initiatives (TCCI) to launch a telemedicine service from a government primary healthcare center (PHC). The service, launched at three healthcare centers, is targeted at the rural masses.

The PGI is being connected to three premier institutes including the All-India Institute of Medical Sciences (AIIMS), Delhi, and the Sanjay Gandhi Postgraduate Institute, Lucknow. Later the PGI will be connected to some more institutes. The introduction of this facility will not only enable the doctors to seek the opinion of experts from across the country but also save patients from the botheration of being referred to other hospitals.

Doctoranywhere.com is a service that allows doctors to be doctors - anywhere - on the Net. An Internet based software and hardware package that provides an affordable, efficient and time-sensitive platform for remote medical consultation to take place easily.

The system was set-up to cater to the emergencies that arise in a huge fair like Kumbmela. Utilising the ISDN telephone lines terminals were set up in Allahabad Medical College and Lucknow and data compression has been used for sending X-ray, ECG, pathological slides, text of medical report, snap shot or live video of the patients to experts sitting in the Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGI) Lucknow. It employed sophisticated encryption technologies to safe guard the confidentiality of the prescription of the doctors from the remote terminals.

In a short span of time, some significant progress has been achieved in the field of Telemedicine in India. However, there is still a long way to go. While there are over 20,000 PHC’s providing primary care services in the rural areas, and about 500 district hospitals, Telemedicine has reached to about 100 centers and more 50% of them are in the urban centers only. For this to be a reality, we need a major thrust not from the government and private sector but also help from international agencies, which will go a long way in achieving this objective.
Table 3.5. Brief description of foremost telemedicine projects in developed countries [17].

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Address/Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAROLIN Cooperative Application for Remote on-line Interactive Diagnosis</td>
<td>Via Fucini, 2, Milano, Italy 20133 <a href="http://www.cefriel.it/item">http://www.cefriel.it/item</a></td>
<td>CAROLIN is a multimedia application for cardiology teleconsulting, developed in the framework of inter-regional cooperation and sponsored by the European Union within the TeleRegions SUN Project. The teleconsultation achieved by CAROLIN is truly cooperative and interactive to navigate through the sequences of digital images, a shared whiteboard to manipulate and annotate single images with text and graphic comments; and an ISDN connection to hold an audio/video conference between physicians.</td>
</tr>
<tr>
<td>Telemedicina CONAE</td>
<td>CETT Ruta C-45, Km 8, Cordoba, Falda de Caquete, Argentina 5187 <a href="http://www.tm.conae.gov.ar/">http://www.tm.conae.gov.ar/</a></td>
<td>The Telemedicine Program developed by the Comision Nacional de Actividades Espaciales of Argentina (CONAE) facilities to improve the quality health care, in rural areas. 24 hrs/day and the remote nodes login by standard telephone lines with modems. With this scheme, a set of telemedical events can be developed, including teleassistance and tele-education. Since 1998 it carried out more than 200 medical events.</td>
</tr>
<tr>
<td>Telemedicine Remote Monitoring</td>
<td>50 Colbee Court, Phillip, ACT, Australia <a href="http://www.approved.com.au">http://www.approved.com.au</a></td>
<td>Using a standard Internet PC with video link, a call centre can monitor a remote patient and check blood pressure, pulse, oximeter, temperature as required. A patient can have a permanent connection with a scheduled check or initialise contact with a call centre. Designed to minimise community nursing visits, and allow persons to stay at home under supervision instead of outpatient clinic, nursing home, or surgery visit.</td>
</tr>
<tr>
<td>Telepsychiatry Network</td>
<td>7 Field Street, Mount Lawley, Perth, Western Australia, Australia 6050</td>
<td>Telepsychiatry is the use of videoconferencing to improve links with rural and remote populations around the state of Western Australia. Some 40 sites located in major and minor service centers as well as the state capital allow face to face contacts between clinicians and consumers.</td>
</tr>
<tr>
<td>A Distributed Telemedicine Network for Eastern North Carolina</td>
<td>East Carolina University School of Medicine, 15-10 Brody Bldg., Greenville, NC 27858 <a href="http://www.telemed.med.ecu.edu/grants.htm">http://www.telemed.med.ecu.edu/grants.htm</a></td>
<td>This project has three components, each of which involves the implementation of independent distributed networks. The first project involves development of telehome care in north eastern North Carolina. Working with a home nursing agency affiliated with a multi-county health department, POTS based home telecare units are being used in patient’s homes. The second project targets telemental health. The third project is a school based telemedicine network linking all the schools within a countywide school district and a paediatrician’s office to provide medical care and other services to students.</td>
</tr>
<tr>
<td>Allina Health System/Rural Health Alliance Telemedicine Network</td>
<td>5601 Smetana Dr, Minnetonka, MN 55343-5010</td>
<td>Telemedicine network exists to improve access of specialists to the rural locations, particularly emergency coverage, to provide continuing education for physicians, nurses, and other providers and employees of Allina and Rural Health Alliance (RHA) hospitals, and to provide videoconferencing to allow for more convenient ‘face-to-face’ communication among employees located at facilities throughout the network.</td>
</tr>
</tbody>
</table>
3.10. Cyber healthcare

Cyber healthcare is a medical remedial solution imparts the delivery of care through its Internet-based technology. It was introduced in the late 1990s for the application of IT in health services supplied by telecommunications or by the Internet. Cyber health care forms a live, interactive community that incorporates all members of the team in the healthcare delivery process, resulting in cost reduction and improvement in the quality of patient care. Cyberhealth services include telemedicine, cybermedicine, teleradiology, telepathology, web-based medical expert systems/decision support systems, availability and usage of medical information and advice. Networking of large health care groups, linking of hospitals and research centers, transfer of diagnostic and therapeutic information, video conferencing, application of hospital information system, expert systems for diagnosis, image analysis and pattern recognition for pathological investigations, telediagnosis and telemedicine, virtual reality training for surgical applications and modeling of brain for psycho physiological and individual animations will be useful and integral part of biomedical technology in the 21st century. No doubt, these have been possible with the introduction of world wide web and internet services resulting the ideas of cyberhealth services [18]. This technology can present virtual house calls, medical market place over the Internet. Medical awareness and mental health services are also available over the system. The Internet is leading to the virtualization of health care, but has created a number of social and ethical challenges before the providers. Internet-based healthcare services are becoming increasingly demanded by patients around the globe.

3.10.1. Cyber medicine

Some authors have employed the term cyber-medicine to refer to those areas of telemedicine delivered via the internet. To be precise, cyber-medicine is medicine in cyberspace where cyberspace denotes the internet. The figure 3.2. illustrates the relationships of telemedicine, cyber medicine, medical informatics, public health, clinical medicine and Internet.
Telemedicine is distinct from cyber-medicine with some overlapping issues. Telemedicine mainly focuses on a restricted exchange of clinical, confidential data with a limited number of patients and physicians. In cyber-medicine, there is a global exchange of information. Furthermore, telemedicine is mainly used for the diagnosis and management of patients while cyber-medicine can be used for research, primary prevention of diseases (e.g., health education websites), tertiary prevention of diseases etc. Despite these differences, cyber-medicine and telemedicine and related disciplines as viewed by Eysenbach [19], and, as concerns about data security are resolved, the boundaries will become increasingly blurred.

3.10.2. Cyber physician

In this fast-growing informatics age, it is envisage that the first point of contact with health care will be through a ‘virtual’ cyber-physician (CP) [20]. Accessed through a display unit, the CP system will replace other forms of triage such as the telephone and give access to information about professionals, hospitals and other aspects of health care. Access to part or all of the user’s health biography would require use of a smart card or a biometric identifier such as retinal vessels. A CP system would bring into sharp relief the role of face-to-face
contact between user and professional. It could make more explicit the demand and need for health care. It could be a mechanism for improving quality, disease management and be a powerful research resource. The CP would be backed by improved knowledge bases and provide the means for creating a huge database of routine information including records kept by patients themselves. Patients would make use and prefer a CP expert facility for a number of reasons than conventional physician, which are mentioned below.

- It may be time-saving and more convenient than seeing a doctor in person.
- Wanting a primary evaluation of a non-urgent medical symptom, not being sure whether it is necessary to see a doctor or not.
- Dissatisfaction with previous doctors.
- Second opinion.
- Preferring to be anonymous, having sensitive or embarrassing questions.
- Discomfort when seeing doctors in person.
- Difficulties accessing health care, e.g. living in rural areas or remote locations.
- Seeking advice for another person such as a relative.
- Other needs that regular health care did not fulfil, such as the wish of getting more thorough information on a medical issue.
- Preference of written communication.

We argue that with the mass access of ICT to patient would more CP-centric in coming future.

3.10.3. Transformation of doctor-patient relations

Numerous observers argue that the Internet has the potential to empower patients and transform the physician-patient relationship. [21]. Cyber health care system is changing the relationship between doctors and patients. There will be a sharp increase in the number and range of systems and organisations that supply information to support health care. These ‘infomediaries’ will guide patients and professionals. More needs to be known about doctors, nurses, support staff, patients and the public, and the technologies required to meet those needs [22]. Public will be able to gather information on any health subject and information available to professionals as well as to patients. Thus, some concerns have been raised that the transformation in the physician-patient relationship, as a consequence of patient’s access to medical knowledge, would contribute to a strained physician-patient relationship [23].
It is seen that cyber health care are mostly 'consumer centric' [24]. The cyberspace is a democratic medium, publishing is inexpensive, simple, and consumers can be a publisher. There are direct, immediate, and efficient feedback channels (e-mail, user statistics, online forms) which tell publishers of information what readers think, what they like and dislike, and giving them the possibility to adapt and refine their contents. Consumer can respond to the needs and demands of consumers quickly, as changes are possible with little costs and virtually no delay.

Some worry that patients who turn to cyber space for information may not consult their doctor when they have a serious health problem. Physicians may feel threatened when patients confront them with information about alternative therapies. Subsequently providers will gather information from experienced patients rather than experts for improvement of patient-relation management. The number and influence of vocal patient groups will increase and the trend towards the internationalisation of health interest groups will grow.

3.10.3.1. Category of CP consultations

It is envisaged that there are two types of CP available for medical consultations. These are distinguished by the kind of relationship between the CP and the patient. These two consultation types can be distinguished from each other, as different behaviour is required by the CP.

In the first case, there is no pre-existing personal relation between the CP and the patient. The consultation is mostly on medical enquiries. Here the consultation made without any personal relation and mainly used at public medical web sites or web-based consultation services, some of which are commercial. This consultation type has been referred to as type-1 provider patient relationship.

On the other hand, in type-2 provider patient relationship, the patient had previous communications with the CP, which mean an established relationship exists between them. The consultation mostly requests for other services such as follow-ups of treatments, emergency advice, prescription renewals, reporting of laboratory results etc.
3.11. Conclusion

Definitely the need has now arisen for awareness/community training in medical Informatics. Health awareness must be spread to the common man and health care professionals should actively involve themselves for motivate the others. [25]. At the same time, The doctors, must be made aware of the potential benefits of medical informatics for reducing time, cost, and increasing quality of healthcare. We expect the future to bring us a 'ubiquitous Internet' where everyone is connected to everyone everywhere. The successful efforts in advanced projects such as the Internet2 and Next Generation Internet indicate that the future of Internet promises to be faster and more reliable. For telemedicine, this means more options to more people. It is expected that the majority of telemedicine applications of the future will operate over the Internet instead of private networks.
Reference


22. James G. Anderson. The Cyber Transformation of Health Care: Critical Social and Ethical Issues, Department of Sociology & Anthropology, Purdue University, West Lafayette, IN 47907 USA

