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REVIEW ARTICLE

Telemedicine: A Review

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ABSTRACT

Telemedicine is an upcoming field in health science arising out of the effective fusion of Information and Communication Technologies (ICT) with medical science having enormous potential in meeting the challenges of healthcare delivery to rural and remote areas besides several other applications in education, training and management in health sector. Telemedicine technology can bring revolution in the field of medicine. Using a number of high speed satellite and terrestrial telecommunications link, centralization and coordination of resources and support of government, it is possible to reach and access the population spread out in heterogeneous geographical set up and thus achieve the goal of health for all. Telemedicine can potentially improve health care in developing countries through providing the services in rural and difficult to access parts of the country, providing the possibility of concentration of expertise and resources, reduction of costs for both patients and providers of health services in some aspects. However, the acceptance and further development of telemedicine depends on various factors like cost/benefit analysis, types of telemedicine systems and applications that are mostly required in a special country.

KEYWORDS

Telemedicine, Telepathology, Tele-cardiology, Teleradiology, Telesurgery, Teleophthalmology, Tele-mentoring, Tele-conferencing

INTRODUCTION

It may be as simple as two health professionals discussing medical problems of a patient and seeking advice over a simple telephone to as complex as transmission of electronic medical records of clinical information, diagnostic tests such as E.C.G., radiological images etc. and carrying out real time interactive medical video conference with the help of IT based hardware and software, video-conference using broadband telecommunication media provided by satellite and terrestrial network.[1] Telemedicine includes a growing variety of applications and services using two-way video, email, smart phones, wireless tools and other forms of telecommunications technology.[2]

Telemedicine, a term coined in the 1970s, which literally means "healing at a distance"[3], signifies the use of ICT to improve patient outcomes by increasing access to care and medical information.

According to World Health Organization the definition of telemedicine is; "The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers,

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all in the interests of advancing the health of individuals and their communities"[4]

Starting out over forty years ago with demonstrations of hospitals extending care to patients in remote areas, the use of telemedicine has spread rapidly and is now becoming integrated into the ongoing operations of hospitals, specialty departments, home health agencies, private physician offices as well as consumer's homes and workplaces.[5]

Telemedicine is not a separate medical specialty. Products and services related to telemedicine are often part of a larger investment by health care institutions in either information technology or the delivery of clinical care. Patient consultations via video conferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education, consumer-focused wireless applications and nursing call centers, among other applications, are all considered part of telemedicine and telehealth.[5]

Telemedicine is a significant and rapidly growing component of healthcare in the United States. There are currently about 200 telemedicine networks, with 3,500 service sites in the US. Nearly 1 million Americans are currently using remote cardiac monitors and in 2011, the Veterans Health Administration delivered over 300,000 remote consultations using telemedicine. Over half of all U.S. hospitals now use some form of telemedicine. Around the world, millions of patients use telemedicine to monitor their vital signs, remain healthy and out of hospitals and emergency rooms. Consumers and physicians download health and wellness applications for use on their cell phones.[6,7]

Origins and History[6,7,8]

Historically, telemedicine can be traced back to the mid to late 19th century (H) with one of the first published accounts occurring in the early 20th century when electrocardiograph data were transmitted over telephone wires.[9] Telemedicine, in its modern form, started in the 1960s in large part driven by the military and space technology sectors, as well as a few individuals using readily available commercial equipment.[8,10]

Examples of early technological milestones in telemedicine include the use of television to facilitate consultations between specialists at a psychiatric institute and general practitioners at a state mental hospital,[11] and the provision of expert medical advice from a major teaching hospital to an airport medical centre.[12] Recent advancements in, and increasing availability and utilization of, ICTs by the general population have been the biggest drivers of telemedicine over the past decade, rapidly creating new possibilities for health care service and delivery. This has been true for developing countries and underserved areas of industrialized nations.[13] The replacement of analogue forms of communication with digital methods, combined with a rapid drop in the cost of ICTs, have sparked wide interest in the application of telemedicine among health-care providers, and have enabled health care organizations to envision and implement new and more efficient ways of providing care.[8,10] The introduction and popularization of the internet has further accelerated the pace of ICT advancements, thereby expanding the scope of telemedicine to encompass Web-based applications (e.g. e-mail, teleconsultations and conferences via the internet) and multimedia approaches (e.g. digital imagery and video).

Types of Telemedicine Process [5,16,17]

Telemedicine process can be categorised in two ways i.e. technology involved and application adopted.

Technology involved

Telemedicine can be broken into three main categories: store-and-forward, remote monitoring and (real-time) interactive services.

(1) Store-and-forward telemedicine or Asynchronous:

Store-and-forward telemedicine involves acquiring medical data (like medical images, biosignals etc.) and then transmitting this data to

a doctor or medical specialist at a convenient time for assessment offline.[16] It does not require the presence of both parties at the same time.[17] Tele-pathology, tele-radiology, tele-dermatology are common specialties that are conducive to asynchronous telemedicine. A properly structured medical record preferably in electronic form should be a component of this transfer. A key difference between traditional in-person patient meetings and telemedicine encounters is the omission of an actual physical examination and history. The 'store-and-forward' process requires the clinician to rely on history report and audio/video information in lieu of a physical examination.

Remote monitoring, also known as self-monitoring or testing, enables medical professionals to monitor a patient remotely using various technological devices. This method is primarily used for managing chronic diseases or specific conditions, such as heart disease, diabetes mellitus, or asthma. These services can provide comparable health outcomes to traditional in-person patient encounters, supply greater satisfaction to patients, and may be cost-effective.

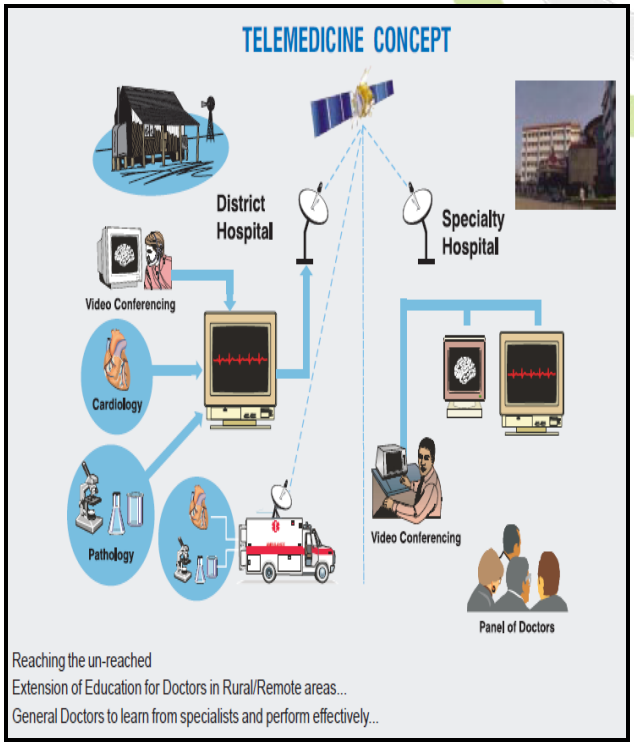

Figure 1: Telemedicine Concept[14,15]

(2) Real Time or Synchronous:

Real time telemedicine could be as simple as a telephone call or as complex as telemedical video conference and tele-robotic surgery. It requires the presence of both parties at the same time and a telecommunication link between them that allows a real-time interaction to take place. Video-conferencing equipment is one of the most common forms of technology used in synchronous telemedicine.

(3) Interactive telemedicine services:

Interactive telemedicine services provide real-time interactions between patient and provider, to include phone conversations, online communication and home visits.[17] Many activities such as history review, physical examination, psychiatric evaluations and ophthalmology assessments can be conducted comparably to those done in traditional face-to-face visits. In addition, "clinician-interactive" telemedicine services may be less costly than in-person clinical visit.

Application Adopted[17]

- Telepathology
- Tele-cardiology
- Teleradiology
- Telesurgery
- Teleophthalmology

Services Provided by Telemedicine[18,19]

- **Primary care and specialist referral services** may involve a primary care or allied health professional providing a consultation with a patient or a specialist assisting the primary care physician in rendering a diagnosis. This may involve the use of live interactive video or the use of store and forward transmission of diagnostic images, vital signs and/or video clips along with patient data for later review.
- **Remote patient monitoring**, including home telehealth, uses devices to remotely collect and send data to a home health agency or a remote diagnostic testing facility

(RDTF) for interpretation. Such applications might include a specific vital sign, such as blood glucose or heart ECG or a variety of indicators for homebound patients. Such services can be used to supplement the use of visiting nurses.

- **Consumer medical and health information** includes the use of the internet and wireless devices for consumers to obtain specialized health information and on-line discussion groups to provide peer-to-peer support.
- **Direct patient care** such as sharing audio, video and medical data between a patient and a health professional for use in rendering a diagnosis, treatment plan, prescription or advice. This might involve patients located at a remote clinic, a physician's office or home.[20]
- **Medical education** provides continuing medical education credits for health professionals and special medical education seminars for targeted groups in remote locations.[20]

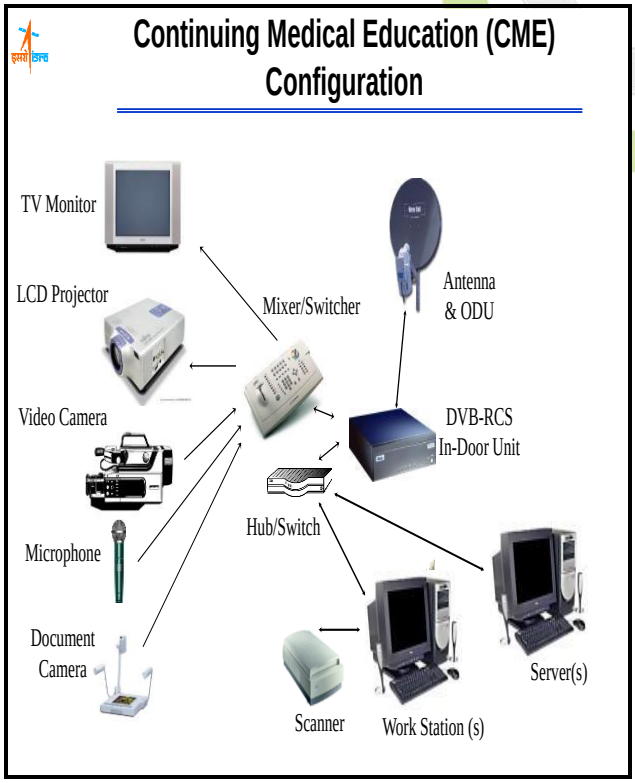

Figure 2: Continuing Medical Education Configuration [20]

Delivery Mechanisms [5,21,22,23]

- **Networked programs** link tertiary care hospitals and clinics with outlying clinics and community health centers in rural or suburban areas. The links may use dedicated high-speed lines or the internet for telecommunication links between sites.
- **Monitoring center links** are used for cardiac, pulmonary or fetal monitoring, home care and related services that provide care to patients in the home. Often normal land-line or wireless connections are used to communicate directly between the patient and the center, although some systems use the internet.
- **Web-based e-health patient service sites** provide direct consumer outreach and services over the Internet. Under telemedicine, these include those sites that provide direct patient care.

Types of Connectivity

- **Point-to-Point communication:** Point-to-point connections using private high speed networks are used by hospitals and clinics that deliver services directly or outsource specialty services to independent medical service providers. Such outsourced services include radiology, stroke assessment, mental health and intensive care services. In networking, the Point-to-Point Protocol (PPP), is a data link protocol commonly used to establish a direct connection between two nodes over terristrial and satellite link e.g. SGPGIMS, Lucknow is connected to the medical colleges of Orissa through point to point connectivity via satellite link and district hospital, Rae Bareli via fiber optic cable network.[24]
- **Point-to-multipoint communication:** It is a term used in the telecommunication field which refers to communication which is accomplished via a specific and distinct type of multipoint connection, providing multiple paths from a single location to multiple locations e.g. two district hospitals of

Uttaranchal state are linked to SGPGIMS via ISDN link.[24]

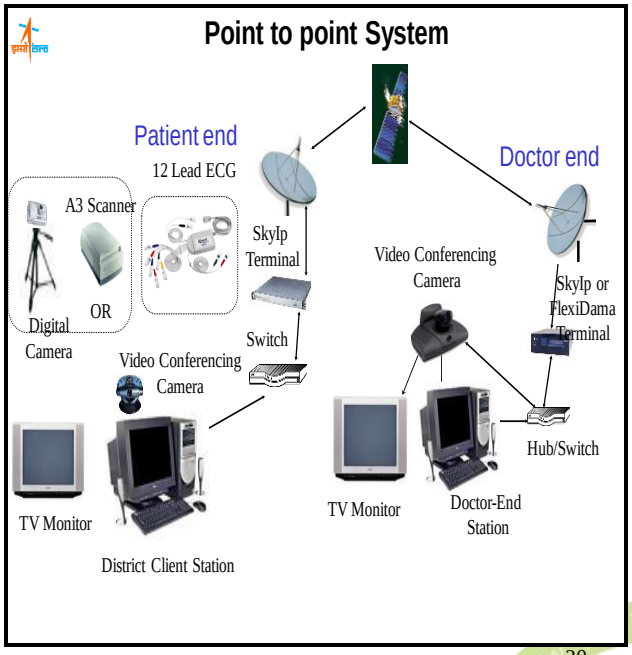

Figure 3: Point-to-Point communication[20]

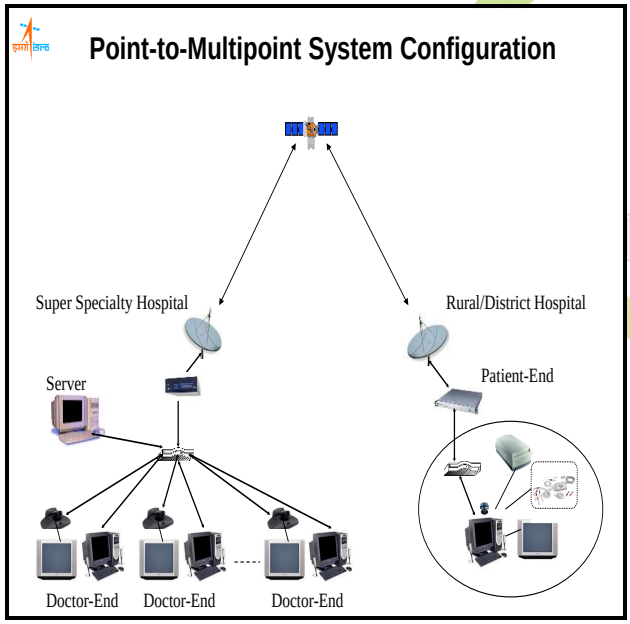

Figure 4: Point-to-multipoint communication[20]

Benefits/Advantages of Telemedicine

- **Improved Access:** Telemedicine has been used to bring healthcare services to patients in distant locations. Not only does telemedicine improve access to patients but it also allows physicians and health facilities to expand their reach, beyond their own offices.[5,25,26]
- **Cost Efficiencies:** Reducing or containing the cost of healthcare is one of the most important reasons for funding and adopting telehealth technologies. Telemedicine has been shown to reduce the cost of healthcare and increase efficiency through better management of chronic diseases, shared health professional staffing, reduced travel times, and fewer or shorter hospital stays.[5, 25, 26]
- **Improved Quality:** Studies have consistently shown that the quality of healthcare services delivered via telemedicine is as good as those given in traditional in-person consulations. In some specialties, particularly in mental health and ICU care, telemedicine delivers a superior product, with greater outcomes and patient satisfaction. [5,25,26]
- **Patient Demand:** Consumers want telemedicine. Telemedicine technologies reduce travel time and related stresses for the patient. Telemedical services offer patients the access to providers that might not be available otherwise, as well as medical services without the need to travel long distances.[5,25,26]

Telemedicine can be beneficial to patients living in isolated communities and remote regions, who can receive care from doctors or specialists far away without the patient having to travel to visit them.[27] Recent developments in mobile collaboration technology can allow healthcare professionals in multiple locations to share information and discuss patient issues as if they were in the same place.[28] Remote patient monitoring through mobile technology can reduce the need for outpatient visits and enable remote prescription verification and drug administration oversight, potentially significantly reducing the overall cost of medical care.[29] Telemedicine can also facilitate medical education by allowing workers to observe experts in their fields and share best practices more easily.[30]

The main objective of telemedicine is to cross the geographical barriers and provide healthcare

facilities to rural and remote areas (health for all) so it is beneficial for the population living in isolated communities. Besides this other advantages of telemedicine are;

- Eliminate distance barriers and improve access to quality health services
- In emergency and critical care situations where moving a patient may be undesirable and/or not feasible
- Facilitate patients and rural practitioners' access to specialist health services and support
- Lessen the inconvenience and/or cost of patient transfers
- Reduce unnecessary travel time for health professionals
- Reduce isolation of rural practice by upgrading their knowledge through tele-education or tele-CME[31]

Recommendations for Videoconferencing-based Telepresenting[32,33,34,6,7]

New challenges and opportunities for the provider have been created by the expansion of communication technologies and new health care delivery models, as a means to enhance delivery of health care. The use of telemedicine/telehealth has extended the reach of the provider, but also may create situations in which assistance is needed in facilitating clinical data transfer from the remote patient setting. A telepresenter (presenter) is frequently used, although not always required, to address the challenges that the consulting provider faces when conducting a physical examination using telemedicine and to ensure efficient information exchange. The presenter is an individual, located at the patient remote site that provides support to the patient and the telemedicine consulting provider, in completing the physical examination and/or telemedicine activity.

The role of presenter will continue to evolve as telemedicine and technology advance, however, presenters are frequently employed to assist with real-time, interactive videoconferencing based consultations between a health care provider and a patient. Presenters may include licensed professionals, parents, spouses, or allied health professionals, depending upon resources within the community and the expertise required to achieve an adequate portrayal of the patient's mental and physical condition. Requirements for a presenter vary widely, based upon the specific patient care settings, the clinical specialty, and expertise of the telemedicine providers. The most qualified telepresenter may in reality, be a lay individual in a community trained in the use of telemedicine technology and who is able to assist the patient. In addition, the evaluating provider must be skilled in leveraging the telemedicine resources to guide the remote assessment and obtain necessary information for determining diagnoses, treatments, and/or care directives.

This expert opinion consensus document focuses on interactive videoconferencing-based telepresenting for health care professionals who are competent in skills and knowledge required to assist the remote provider, and serves as a guide for health professionals engaging lay presenters, such as family members. The purpose of this document is to define the requirements for serving as a telepresenter, as well as identifying key points to be considered throughout the process of telepresenting. The document is divided into administrative, technical, and clinical domains.

Telemedicine has transformed the delivery of healthcare, yet, successful use of technology is dependent upon efficient information exchange. It is the presenter who supports communication and physical requirements of both the patient and evaluating provider throughout the tele-encounter process.

Applications of Telemedicine[35]

1. **Tele-health care:** It is the use of information and communication technology for prevention, promotion and to provide health care facilities across distance. It can be divided in the following activities
    - Teleconsultation

- Telefollow-up

2. **Tele-education:** Tele-education should be understood as the development of the process of distance education (regulated or unregulated), based on the use of information and telecommunication technologies, that make interactive, flexible and accessible learning possible for any potential recipient.
3. **Disaster Management:** Telemedicine can play an important role to provide healthcare facilities to the victims of natural disasters such as earthquake, tsunami, tornado, etc. and man-made disaster such as war, riots, etc. During disaster, most of the terrestrial communication links either do not work properly or get damaged so a mobile and portable telemedicine system with satellite connectivity and customized telemedicine software is ideal for disaster relief.
4. **Tele-home health care:** Telemedicine technology can be applied to provide home health care for elderly or underserved, homebound patients with chronic illness. It allows home healthcare professionals to monitor patients from a central station rather than travelling to remote areas chronically ill or recuperating patients for routine check-ups. Remote patient monitoring is less expensive, more time savings, and efficient methodology. Tele-home care virtual visits might lead to improved home health care quality at reduced costs, greater patient satisfaction with care, increased access to health care providers and fewer patients needing transfer to higher, more costly levels of care. A Computer Telephone Integrated (CTI) system can monitor vital functions of patients twenty four hours a day and give immediate warnings.

Draw backs

The downsides of telemedicine include the cost of telecommunication and data management equipment and of technical training for medical personnel who will employ it. Virtual medical treatment also entails potentially decreased human interaction between medical professionals and patients, an increased risk of error when medical services are delivered in the absence of a registered professional, and an increased risk that protected health information may be compromised through electronic storage and transmission.[36]

There is also a concern that telemedicine may actually decrease time efficiency due to the difficulties of assesing and treating patients through virtual interactions; for example, it has been estimated that a teledermatology consultation can take up to thirty minutes, whereas fifteen minutes is typical for a traditional consultation.[37] Additionally, potentially poor quality of transmitted records, such as images or patient progress reports, and decreased access to relevant clinical information are quality assurance risks that can compromise the quality and continuity of patient care for the reporting doctor.[36] Other obstacles to the implementation of telemedicine include unclear legal regulation for some telemedical practices and difficulty claiming reimbursement from insurers or government programs in some fields.[38]

Barriers in Telemedicine Practice[39]

Physician/Patient Acceptance

Physicians and patients have unique technological resources available to improve the patient-physician relationship. It has been found that patients have no difficulty in accepting telemedicine program. The survey conducted by SGPGIMS tele-follow up program for the patients of Orissa state revealed that 99% patients were satisfied with using telemedicine technology. In almost all the cases the patients are more than happy and satisfied as they don't have to travel 1500 km to show their diagnostic reports to their doctors. In tele-consultation they were also happy that they get the specialist consultation and their cases has been seen by some expert doctors.

However, some resistance is seen amongst doctors. Doctors in government sector tend to look upon telemedicine as an additional duty or

workload. Therefore, there is need to weave telemedicine into the routine duties of the doctors. The private doctors sometime fear that telemedicine is likely to reduce their practice. They need to realize that this technology enhances their reach and exposure and is only likely to increase their practice further.

Availability of Technology at a Reasonable Cost

It is myth that to establish a telemedicine platform is an expensive. The basic system needs hardware, software and telecommunication link. In all the areas there is a significant reduction in the prices. Most of these costs are well within the reach of most of the hospitals, and can be recovered by nominal charge to the patients and students in case of tele-education which would be much less than the physically traveling.

Accessibility

Although information technology has reached in all corner of the country but the accessibility of people living in remote and rural area to the nearest health center (PHCs, CHCs or district hospital) may not be easy due to poor infrastructure of road and transport. It may be possible that the available telemedicine system in the health centers may not function because of the interruption in power supply.

Reliability

Some healthcare professionals has doubt about the quality of images transmitted for tele-consultation and tele-diagnois. In tele-radiology, telepathology, tele-dermatology the quality of image (colour, resolution, field of view, etc) should be international standards to avoid any wrong interpretation and mis-diagnosis. The delay in transmission of data may be of critical importance in tele-mentoring and robotic surgery and have to be reduced to the minimum.

Funding/ Reimbursement Issues

There should be a format to calculate the investment and recurring cost of the telemedicine system. The insurance companies have to decide whether the cost of tele-healthcare should be reimburse or not.

Lack of Trained Manpower

Telemedicine is a new emerging field, there is lack of training facilities with regards to application of IT in the field of medicine. Most of the healthcare and IT professionals are not familiar with the terms commonly used in telemedicine such as HIS, EMR, PACS, etc. Telemedicine is also not the part of course curriculum of medical schools.

Legal & Ethical

Telemedicine technology has been proved and established and its advantages and benefits are well known but still many healthcare professionals are reluctant to engage in such practices due to unresolved legal and ethical concerns. In case of a cross-border tele-consultation which country's litigation laws will be applied in case – those of the country in which the patient is living or those of the remote physician?

Privacy and Security Concerns

There are many issue that should be considered regarding the security, privacy and confidentiality of patient data, in telemedicine consultations i.e, how are patients' rights of confidentiality of their personal data ensured and protected?, how to ensure security of the data and restrict its availability to only those for whom it is intended and who are authorised and entitled to view it?, how to prevent misuse and even abuse of electronic records in the form of unauthorised interception and/or disclosure?

Expected Problems with Telemedicine in Third World Countries[40]

Financial

- Increase of costs because of improving the quality of service through providing second opinion
- Who pays for the expenses
- Cost effectiveness assessment

Liability

- Who is responsible for the patient?
- Anyone can establish a web site to offer consulting

Acceptance

- Physicians resist to use a new technology that they do not understand
- Patients and doctors are accustomed to personal visits and are reluctant to alter the traditional method of care
- Privacy and confidentiality of information
- Insurance

Technology

- Scarcity of high-bandwidth telecommunication networks in rural areas
- Compatibility of old equipment with telemedicine

Main Pillars of Telemedicine[41,42,43]

Tele-Mentoring /Tele-Proctoring[42,43]

It is mentoring and evaluation of surgical trainees from distance with the involvement of broadband connectivity, power cams, and sophisticated videoconferencing equipment. A real time and live interactive teaching of techniques or procedures by a teleproctor to a student. The teleproctor is in one location and the student is in another.

The teleproctor must have the ability to see the performance of the procedure or technique being executed by the student in real time. The teleproctor and the student must have the ability to verbally communicate during the session. Implicit in the definition of teleproctoring is that the teleproctor does not have the ability to physically intervene on-site and can therefore not assume primary patient care responsibility.

Appropriate use:

- Demonstration and/or teaching technique or procedures using inanimate trainers.
- Demonstration and/or teaching techniques or procedures using animate ex vivo models.
- Demonstration and teaching techniques or procedures on patients as an adjunct teacher when a qualified preceptor is on-site with the student.

Tele-Conferencing[43]

Tele-conferencing is the discussion and interaction between doctors during workshop, conferences, seminar or continual medical education programs in a visual room environment. Live surgery demonstration or procedures can be transmitted through videoconference during these programs. One of the widely used technology it has now changed the concept of physical presence in any of the above events.

Different kinds of teleconferencing modalities are now in use such as interactive two way, one way broadcast, web cast etc. Once the cost of broadband telecommunication comes down and internet technology is advanced more and more people would like to stay afoot at their place of work and participate in events remotely.

Tele-Consultation[43]

Evaluation of patient(s), and/or patient data, and consultation regarding patient management, from a distant site, using a telecommunications interface. The teleconsultant, by definition, does not have the ability to physically interact with the patient, except through the telecommunications interface.

Appropriate Use:

- Initial urgent evaluation of patients, triage decisions, and pretransfer arrangements for patients in an urgent/emergency situation
- Intra-operative consultations
- Supervision and consultation for primary care encounters in sites where an equivalently qualified physician/surgeon is not available
- Routine consultations and second opinions based on history, physical findings, and available test data
- Public health, preventive medicine, and patient education

Different Types of Telemedicine Systems according to their use in Health care[44]

- Tele-education
- Medical emergencies and distant
- Teleconsultation
- Telediagnosis relief
- Telesurgery and virtual reality

Different Types of Telemedicine Systems according to the Medical Applications[44]

- Teleradiology
- X- Ray
- CT
- MRI
- NM (Nuclear Medicine)
- Fluoroscopy
- Angiography
- Ultrasound
- Thermography
- Telepathology
- Teledermatology
- Tele-endoscopy
- Telecardiology
- Telepsychiatry
- Telepharmacy
- Telemetry

Emergency Telemedicine[45]

U.S. Navy medical staff being trained in the use of handheld telemedical devices (2006).

Common daily emergency telemedicine is performed by SAMU Regulator Physicians in France, Spain, Chile, Brazil. Aircraft and maritime emergencies are also handled by SAMU centres in Paris, Lisbon and Toulouse.[45]

A recent study identified three major barriers to adoption of telemedicine in emergency and critical care units. They include:

- Regulatory challenges related to the difficulty and cost of obtaining licensure across multiple states, malpractice protection and privileges at multiple facilities
- Lack of acceptance and reimbursement by government payers and some commercial insurance carriers creating a major financial barrier, which places the investment burden squarely upon the hospital or healthcare system.
- Cultural barriers occurring from the lack of desire, or unwillingness, of some physicians to adapt clinical paradigms for telemedicine applications.[46]

General Health Care Delivery[47]

The first interactive telemedicine system, operating over standard telephone lines, designed to remotely diagnose and treat patients requiring cardiac resuscitation (defibrillation) was developed and launched by an American company, MedPhone Corporation, in 1989. A year later under the leadership of its President/CEO S Eric Wachtel, MedPhone introduced a mobile cellular version, the MDPhone. Twelve hospitals in the U.S. served as receiving and treatment centers.[48]

In general, a patient will have a number of monitoring devices at home, and the results of these devices will be transmitted via telephone to the health care provider. Telemonitoring is a convenient way for patients to avoid travel and to perform some of the more basic work of healthcare for themselves.

In addition to objective technological monitoring, most telemonitoring programs include subjective questioning regarding the patient's health and comfort. This questioning can take place automatically over the phone, or telemonitoring software can help keep the patient in touch with the health care provider. The provider can then make decisions about the patient's treatment based on a combination of subjective and objective information similar to what would be revealed during an on-site appointment.

Some of the more common things that telemonitoring devices keep track of include blood pressure, heart rate, weight, blood glucose, and hemoglobin. Telemonitoring is capable of providing information about any vital signs, as long as the patient has the necessary monitoring equipment at his or her location. Depending on the severity of the patient's condition, the provider may check these statistics on a daily or weekly basis to determine the best course of treatment.

The first Ayurvedic telemedicine center was established in India in 2007 by Partap Chauhan, an Indian Ayurvedic doctor and the Director of Jiva Ayurveda. Teledoc used Nokia phones running Javascript to link mobile ayurvedic field techs with doctors in the Jiva Institute clinic; at its peak, Teledoc reached about 1,000 villagers per month in Haryana province, primarily treating chronic diseases such as diabetes.

Monitoring a patient at home using known devices like blood pressure monitors and transferring the information to a caregiver is a fast growing emerging service. These remote monitoring solutions have a focus on current high morbidity chronic diseases and are mainly deployed for the First World. In developing countries a new way of practicing telemedicine is emerging better known as Primary Remote Diagnostic Visits, whereby a doctor uses devices to remotely examine and treat a patient. This new technology and principle of practicing medicine holds significant promise of improving on major health care delivery problems, in for instance, Southern Africa, because Primary Remote Diagnostic Consultations not only monitors an already diagnosed chronic disease, but has the promise to diagnose and manage the diseases patients will typically visit a general practitioner for.

Telenursing[49]

Telenursing refers to the use of telecommunications and information technology in order to provide nursing services in health care whenever a large physical distance exists between patient and nurse, or between any number of nurses. As a field it is part of telehealth, and has many points of contacts with other medical and non-medical applications, such as telediagnosis, teleconsultation, telemonitoring, etc.

Telenursing is achieving significant growth rates in many countries due to several factors: the preoccupation in reducing the costs of health care, an increase in the number of aging and chronically ill population, and the increase in coverage of health care to distant, rural, small or sparsely populated regions. Among its benefits, telenursing may help solve increasing shortages of nurses; to reduce distances and save travel time, and to keep patients out of hospital. A greater degree of job satisfaction has been registered among telenurses.

Telepharmacy[50]

Telepharmacy is the delivery of pharmaceutical care via telecommunications to patients in locations where they may not have direct contact with a pharmacist. It is an instance of the wider phenomenon of telemedicine, as implemented in the field of pharmacy. Telepharmacy services include drug therapy monitoring, patient counselling, prior authorization and refill authorization for prescription drugs, and monitoring of formulary compliance with the aid of teleconferencing or videoconferencing. Remote dispensing of medications by automated packaging and labeling systems can also be thought of as an instance of telepharmacy. Telepharmacy services can be delivered at retail pharmacy sites or through hospitals, nursing homes, or other medical care facilities.

The term can also refer to the use of videoconferencing in pharmacy for other purposes, such as providing education, training, and management services to pharmacists and pharmacy staff remotely.[38]

Telerehabilitation[51,52]

Telerehabilitation or e-rehabilitation is the delivery of rehabilitation services over telecommunication networks and the Internet.[51,52] Most types of services fall into two categories: clinical assessment (the patient's

functional abilities in his or her environment), and clinical therapy. Some fields of rehabilitation practice that have explored telerehabilitation are: neuropsychology, speech-language pathology, audiology, occupational therapy and physical therapy. Telerehabilitation can deliver therapy to people who cannot travel to a clinic because the patient has a disability or because of travel time. Telerehabilitation also allows experts in rehabilitation to engage in a clinical consultation at a distance.

Most telerehabilitation is highly visual. As of 2006 the most commonly used modalities are via webcams, videoconferencing, phone lines, videophones and webpages containing rich internet applications. The visual nature of telerehabilitation technology limits the types of rehabilitation services that can be provided. It is most widely used for neuropsychological rehabilitation; fitting of rehabilitation equipment such as wheelchairs, braces or artificial limbs; and in speech-language pathology. Rich internet applications for neuropsychological rehabilitation (aka cognitive rehabilitation) of cognitive impairment (from many etiologies) was first introduced in 2001. This endeavor has expanded as a teletherapy application for cognitive skills enhancement programs for school children. Tele-audiology (hearing assessments) is a growing application. As of 2006, telerehabilitation in the practice of occupational therapy and physical therapy are very limited, perhaps because these two disciplines are more "hands on".

Two important areas of telerehabilitation research are; (1) demonstrating equivalence of assessment and therapy to in-person assessment and therapy, and (2) building new data collection systems to digitize information that a therapist can use in practice. Ground-breaking research in telehaptics (the sense of touch) and virtual reality may broaden the scope of telerehabilitation practice, in the future.

In the United States, the National Institute on Disability and Rehabilitation Research (NIDRR) supports research and the development of telerehabilitation. NIDRR's grantees include the "Rehabilitation Engineering and Research Center" (RERC) at the University of Pittsburgh, the Rehabilitation Institute of Chicago, the State University of New York at Buffalo, and the National Rehabilitation Hospital in Washington DC. Other federal funders of research are the Veterans Administration, the Health Services Research Administration in the US Department of Health and Human Services, and the Department of Defense. Outside the United States, excellent research is conducted in Australia and Europe.

As of 2006, only a few health insurers in the United States will reimburse for telerehabilitation services. If the research shows that teleassessments and teletherapy are equivalent to clinical encounters, it is more likely that insurers and Medicare will cover telerehabilitation services.

Teletrauma Care[53,54,55,56]

Telemedicine can be utilized to improve the efficiency and effectiveness of the delivery of care in a trauma environment. Examples include:

Telemedicine for trauma triage:

Using telemedicine, trauma specialists can interact with personnel on the scene of a mass casualty or disaster situation, via the internet using mobile devices, to determine the severity of injuries. They can provide clinical assessments and determine whether those injured must be evacuated for necessary care. Remote trauma specialists can provide the same quality of clinical assessment and plan of care as a trauma specialist located physically with the patient. [53]

Telemedicine for intensive care unit (ICU) rounds:

Telemedicine is also being used in some trauma ICUs to reduce the spread of infections. Rounds are usually conducted at hospitals across the country by a team of approximately ten or more people to include attending physicians, fellows, residents and other clinicians. This group usually moves from bed to bed in a unit discussing each patient. This aids in the

transition of care for patients from the night shift to the morning shift, but also serves as an educational experience for new residents to the team. A new approach features the team conducting rounds from a conference room using a video-conferencing system. The trauma attending, residents, fellows, nurses, nurse practitioners, and pharmacists are able to watch a live video stream from the patient's bedside. They can see the vital signs on the monitor, view the settings on the respiratory ventilator, and/or view the patient's wounds. Video-conferencing allows the remote viewers two-way communication with clinicians at the bedside.[54]

Telemedicine for trauma education:

Some trauma centers are delivering trauma education lectures to hospitals and health care providers worldwide using video conferencing technology. Each lecture provides fundamental principles, firsthand knowledge and evidenced-based methods for critical analysis of established clinical practice standards, and comparisons to newer advanced alternatives. The various sites collaborate and share their perspective based on location, available staff, and available resources.[55]

Telemedicine in the trauma operating room:

Trauma surgeons are able to observe and consult on cases from a remote location using video conferencing. The remote surgeon has the capability to control the camera (pan, tilt and zoom) to get the best angle of the procedure while at the same time providing expertise in order to provide the best possible care to the patient.[56]

Specialist care delivery:

Telemedicine can facilitate specialty care delivered by primary care physicians according to a controlled study of the treatment of hepatitis C.[56,57,58] Various specialties are contributing to telemedicine, in varying degrees.

Telecardiology[59]

ECGs, or electrocardiographs, can be transmitted using telephone and wireless. Willem Einthoven, the inventor of the ECG, actually did tests with transmission of ECG via telephone lines. This was because the hospital did not allow him to move patients outside the hospital to his laboratory for testing of his new device. In 1906 Einthoven came up with a way to transmit the data from the hospital directly to his lab.[47]

Teletransmission of ECG using Methods Indigenous to Asia[59]

One of the oldest known telecardiology systems for teletransmissions of ECGs was established in Gwalior, India in 1975 at GR Medical College by Dr. Ajai Shanker, Dr. S. Makhija, P.K. Mantri using an indegenous technique for the first time in India.

This system enabled wireless transmission of ECG from the moving ICU van or the patients home to the central station in ICU of the department of Medicine. Transmission using wireless was done using frequency modulation which eliminated noise. Transmission was also done through telephone lines. The ECG output was connected to the telephone input using a modulator which converted ECG into high frequency sound. At the other end a demodulator reconverted the sound into ECG with good gain accuracy. The ECG was converted to sound waves with a frequency varying from 500 Hz to 2500 Hz with 1500 Hz at baseline.

This system was also used to monitor patients with pacemakers in remote areas. The central control unit at the ICU was able to correctly interpret arrhythmia. This technique helped medical aid reach in remote areas.[59]

In addition, electronic stethoscopes can be used as recording devices, which is helpful for purposes of telecardiology. There are many examples of successful telecardiology services worldwide.

In Pakistan three pilot projects in telemedicine was initiated by the Ministry of IT & Telecom, Government of Pakistan (MoIT) through the Electronic Government Directorate in collaboration with Oratier Technologies (a

pioneer company within Pakistan dealing with healthcare and HMIS) and PakDataCom (a bandwidth provider). Three hub stations were linked via the Pak Sat-I communications satellite, and four districts were linked with another hub. A 312 Kb link was also established with remote sites and 1 Mbit/s bandwidth was provided at each hub. Three hubs were established: the Mayo Hospital (the largest hospital in Asia), JPMC Karachi and Holy Family Rawalpindi. These 12 remote sites were connected and on average of 1,500 patients being treated per month per hub.[59]

Telepsychiatry[60,61]

Telepsychiatry, another aspect of telemedicine, also utilizes videoconferencing for patients residing in underserved areas to access psychiatric services. It offers wide range of services to the patients and providers, such as consultation between the psychiatrists, educational clinical programs, diagnosis and assessment, medication therapy management, and routine follow-up meetings.[60]

As of 2011, the following are some of the model programs and projects which are deploying telepsychiatry in rural areas in the United States:

1. University of Colorado Health Sciences Center (UCHSC) supports two programs for American Indian and Alaskan Native populations

a. The Center for Native American Telehealth and Tele-education (CNATT) and

b. Telemental Health Treatment for American Indian Veterans with Post-traumatic Stress Disorder (PTSD)

2. Military Psychiatry, Walter Reed Army Medical Center.

3. In 2009, the South Carolina Department of Mental Health established a partnership with the University of South Carolina School of Medicine and the South Carolina Hospital Association to form a statewide telepsychiatry program that provides access to psychiatrists 16 hours a day, 7 days a week, to treat patients with mental health issues who present at rural emergency departments in the network.

4. Between 2007 and 2012, the University of Virginia Health System hosted a videoconferencing project that allowed child psychiatry fellows to conduct approximately 12,000 sessions with children and adolescents living in rural parts of the State.[62]

There are a growing number of HIPAA compliant technologies for performing telepsychiatry. There is an independent comparison site of current technologies.

Links for several sites related to telemedicine, telepsychiatry policy, guidelines, and networking are available at the website for the American Psychiatric Association.[63,17]

There has also been a recent trend towards Video CBT sites with the recent endorsement and support of CBT by the National Health Service (NHS) in the United Kingdom.

In the United States, the American Telemedicine Association and the Center of Telehealth and eHealth are the most respectable places to go for information about telemedicine.

The momentum of telemental health and telepsychiatry is growing. In June 2012 the U.S. Veterans Administration announced expansion of the successful telemental health pilot. Their target was for 200,000 cases in 2012.[64]

A growing number of HIPAA compliant technologies are now available. There is an independent comparison site that provides a criteria based comparison of telemental health technologies.[16]

Teleradiology[65]

Teleradiology is the ability to send radiographic images (x-rays, CT, MR, PET/CT, SPECT/CT, MG, US...) from one location to another.[16] For this process to be implemented, three essential components are required, an image sending station, a transmission network, and a receiving-image review station. The most typical implementation are two computers connected via the internet. The computer at the receiving end will need to have a high-quality display

screen that has been tested and cleared for clinical purposes. Sometimes the receiving computer will have a printer so that images can be printed for convenience.[65]

The teleradiology process begins at the image sending station. The radiographic image and a modem or other connections are required for this first step. The image is scanned and then sent via the network connection to the receiving computer.[65]

Today's high-speed broadband based internet enables the use of new technologies for teleradiology: the image reviewer can now have access to distant servers in order to view an exam. Therefore, they do not need particular workstations to view the images; a standard Personal Computer (PC) and Digital Subscriber Line (DSL) connection is enough to reach keosys central server. No particular software is necessary on the PC and the images can be reached from wherever in the world.[65]

Teleradiology is the most popular use for telemedicine and accounts for at least 50% of all telemedicine usage.

Telepathology[66]

Telepathology is the practice of pathology at a distance. It uses telecommunications technology to facilitate the transfer of image-rich pathology data between distant locations for the purposes of diagnosis, education, and research.[66,67] Performance of telepathology requires that a pathologist selects the video images for analysis and the rendering diagnoses. The use of "television microscopy", the forerunner of telepathology, did not require that a pathologist have physical or virtual "hands-on" involvement is the selection of microscopic fields-of-view for analysis and diagnosis.[66]

A pathologist, Ronald S. Weinstein, M.D., coined the term "telepathology" in 1986. In an editorial in a medical journal, Weinstein outlined the actions that would be needed to create remote pathology diagnostic services.[68] He, and his collaborators, published the first scientific paper on robotic telepathology.[69] Weinstein was also granted the first U.S. patents for robotic telepathology systems and telepathology diagnostic networks.[70] Dr. Weinstein is known to many as the "father of telepathology".[71] In Norway, Eide and Nordrum implemented the first sustainable clinical telepathology service in 1989.[72] This is still in operation, decades later. A number of clinical telepathology services have benefited many thousands of patients in North America, Europe, and Asia.[72]

Telepathology has been successfully used for many applications including the rendering histopathology tissue diagnoses, at a distance, for education, and for research. Although digital pathology imaging, including virtual microscopy, is the mode of choice for telepathology services in developed countries, analog telepathology imaging is still used for patient services in some developing countries.[71]

Teledermatology[73,74,75,76,77]

Teledermatology is a subspecialty in the medical field of dermatology and one of the more common applications of telemedicine and e-health. In teledermatology, telecommunication technologies are used to exchange medical information (concerning skin conditions and tumours of the skin) over a distance using audio, visual and data communication. Teledermatology can reduce wait times by allowing dermatologists to treat minor conditions online while serious conditions requiring immediate care are given priority for appointments. Applications comprise health care management such as diagnoses, consultation and treatment as well as (continuous) education.

The dermatologists Perednia and Brown were the first to coin the term "teledermatology" in 1995. In a scientific publication, they described the value of a teledermatologic service in a rural area underserved by dermatologists.

Teledentistry

Teledentistry is the use of information technology and telecommunications for dental care, consultation, education, and public

awareness in the same manner as telehealth and telemedicine.[77]

Teleaudiology

Tele-audiology is the utilization of telehealth to provide audiological services and may include the full scope of audiological practice.[78]

This term was first used by Dr. Gregg Givens in 1999 in reference to a system being developed at East Carolina University in North Carolina, USA. The first Internet audiological test was accomplished in 2000 by Givens, Balch and Keller.

The first Transatlantic teleaudiology test was performed in April 2009 when Dr. James Hall tested a patient in South Africa from Dallas.[78]

Teleophthalmology[57,79, 80]

Teleophthalmology is a branch of telemedicine that delivers eye care through digital medical equipment and telecommunications technology. Today, applications of teleophthalmology encompass access to eye specialists for patients in remote areas, ophthalmic disease screening, diagnosis and monitoring; as well as distant learning. Teleophthalmology may help reduce disparities by providing remote, low-cost screening tests such as diabetic retinopathy screening to low-income and uninsured patients.

U.S. Licensing and Regulatory Issues

Restrictive licensure laws in the United States require a practitioner to obtain a full license to deliver telemedicine care across state lines. Typically, states with restrictive licensure laws also have several exceptions (varying from state to state) that may release an out-of-state practitioner from the additional burden of obtaining such a license. A number of states require practitioners who seek compensation to frequently deliver interstate care to acquire a full license.[81,82]

If a practitioner serves several states, obtaining this license in each state could be an expensive and time-consuming proposition. Even if the practitioner never practices medicine face-to-face with a patient in another state, he/she still must meet a variety of other individual state requirements, including paying substantial licensure fees, passing additional oral and written examinations, and travelling for interviews.[81,82]

Regulations concerning the practice of telemedicine vary from state to state.[83] Physicians who will be prescribing over the internet to patients should mandate strict controls on their practice to insure that they stay compliant with the various State Medical Board Regulations concerning internet prescribing.[84]

Advanced and Experimental Services

Telesurgery

Remote surgery (also known as telesurgery) is the ability for a doctor to perform surgery on a patient even though they are not physically in the same location. It is a form of telepresence. Remote surgery combines elements of robotics, cutting edge communication technology such as high-speed data connections and elements of management information systems. While the field of robotic surgery is fairly well established, most of these robots are controlled by surgeons at the location of the surgery.[84]

Remote surgery is essentially advanced telecommuting for surgeons, where the physical distance between the surgeon and the patient is immaterial. It promises to allow the expertise of specialized surgeons to be available to patients worldwide, without the need for patients to travel beyond their local hospital.[84]

Enabling Technologies

Videotelephony

Videotelephony comprises the technologies for the reception and transmission of audio-video signals by users at different locations, for communication between people in real-time.[85]

At the dawn of the technology, videotelephony also included *image phones* which would exchange still images between units every few seconds over conventional POTS-type telephone lines, essentially the same as slow scan TV systems.[85] Currently videotelephony is particularly useful to the deaf and speech-impaired who can use them with sign language

and also with a video relay service, as well as to those with mobility issues or those who are located in distant places and are in need of telemedical or tele-educational services.[85]

Health Information Technology

Health information technology (HIT) provides the umbrella framework to describe the comprehensive management of health information across computerized systems and its secure exchange between consumers, providers, government and quality entities, and insurers. Health information technology (HIT) is in general increasingly viewed as the most promising tool for improving the overall quality, safety and efficiency of the health delivery system.[86] Broad and consistent utilization of HIT will:

- Improve health care quality;
- Prevent medical errors;
- Reduce health care costs;
- Increase administrative efficiencies
- Decrease paperwork; and
- Expand access to affordable care.

Interoperable HIT will improve individual patient care, but it will also bring many public health benefits including:

- Early detection of infectious disease outbreaks around the country;
- Improved tracking of chronic disease management; and
- Evaluation of health care based on value enabled by the collection of de-identified price and quality information that can be compared.

Telemedicine in our Society[7,87]

During the national conference on telemedicine held in Lucknow in April 2001 the participants resolved to form a scientific society dedicated to telemedicine at national level and carry out annual scientific event pending a formal registration, thus the telemedicine society of India was born and all the participants signed a resolution to this effect and are made the founding members. The first annual conference of the society was held in Lucknow in the subsequent year and all the participants were inducted to the founding member group. In the following two years there was no scientific activity till March 2005 when an International Conference on Telemedicine (INTELMED 2005) was hosted by Indian Space Research Organization (ISRO) at Bangalore. During this event a general body meeting was held among the founding members present to resolve to form an interim executive body to initially take the responsibility of steering the activities of the society till the formal registration of the society and election of executive is held thereafter. Unanimously the following interim group of executive was formed; Dr S. S. Badrinath, Chairman, Sankara Nethralaya (Founder President), Sri Bhaskaranarayana of ISRO (Vice President), Prof. Saroj Mishra (Secretary) and Prof. K. Ganapathy (Joint Secretary-cum-Treasurer). Members of the executive body was selected from among representative of various ministries of Government supporting telemedicine activities (Department of Information Technology & Indian Space Research Organization), defense services, academic organizations playing active role in telemedicine (AIIMS, New Delhi & SGPGI, Lucknow) and Indian office of WHO. The society got formally registered in 2006 at Lucknow having its registered office at telemedicine center, Sanjay Gandhi Postgraduate Institute of Medical Sciences. Considerable progress has been made over last few years. The society had its first, second, third and fourth annual conferences held at New Delhi (2006), Chennai (2007) and Chandigarh (2008) respectively. The telemedicine society of India, is now a reality. The international society for telemedicine and e-health, has now recognized TSI as the official national society representing telemedicine activities in India.

Advantages of Satellite Communication[88]

- Easy reach, quick installation
- No geographical and environmental barriers
- Flexible, high quality network

- Extensive and Consistent geographic coverage
- Efficient support to broadcast and multipoint communications for medical education and consultation sessions
- Network capacity flexibility, reliability and security

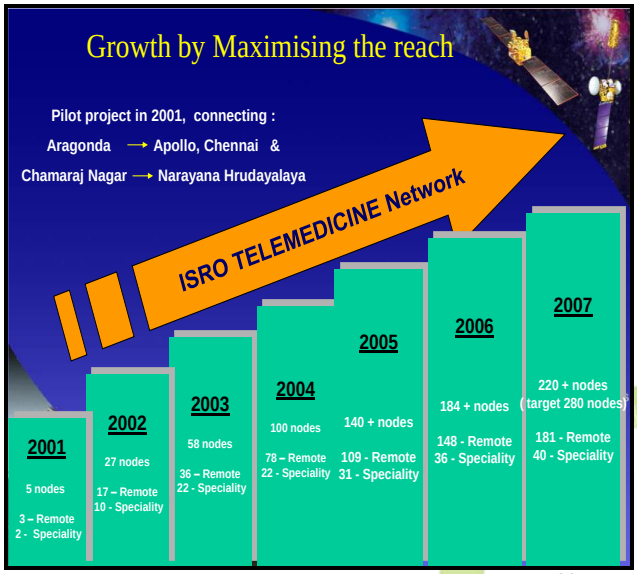

Figure 5: ISRO Telemedicine network[89]

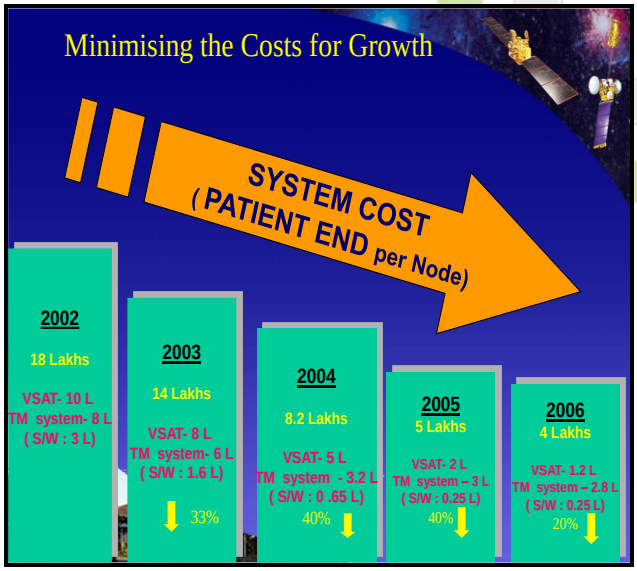

Figure 6: System cost (Patient end per node)[89,88]

Telemedicine in India: Current Scenario and the Future[90]

The triangular Indian peninsula holds every kind of landscape spread over an area of 3 million sq km and having more than 1 billion population with 29 States and 6 Union Territories governed by a federal system. Government-supported healthcare delivery follows a three tier system and is primary responsibility of the state. There is no national health insurance policy. Almost 75% of the population resides in rural areas lacking access to medical expertise and infrastructure.

Further, healthcare delivery is difficult in the inhospitable geographical terrain like mountain regions in the north-east, deserts of north-west and the off-shore islands of Andaman and Lakshadweep. Telemedicine technology can bridge this divide by integrating this tool into the existing healthcare delivery system irrespective of socio-economic and geographical disparities.

- Agencies like ISRO, Dept of IT, Railways, Few State governments, Private network by Apollo, AHF, AIMS, ESCORTS etc are also part of this movement in their own capacity.[91,92]

Many developments have taken place in the field of telemedicine as a result of contribution by both government and private sector to various activities.

Initiatives taken by Ministries of Central Government of India (GoI)[93]

Department of Information Technology (DIT) Ministry of Communications and IT

(MCIT): Some of the successful telemedicine projects implemented by DIT in various states are telemedicine network in West Bengal for diagnosis and monitoring of tropical diseases and cancer care, Kerala and Tamilnadu Oncology network for facilitating cancer care and provision of specialty healthcare access in rural areas of Punjab, Maharashtra, hilly state of Himachal Pradesh and North-Eastern region. It also established link among the three premier institutions viz. Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow, All India Institute of Medical Sciences (AIIMS), New Delhi, Post Graduate Institute of Medical Sciences (PGIMER),

Chandigarh which in turn connected to the state level hospitals.

Indian Space Research Organization (ISRO)
ISRO's 2 satellite based Telemedicine network via Indian Satellite System which started in 2001under GRAMSAT (rural satellite) program nowincludes 439 Hospitals-382 Remote/Rural District Hospitals/ Health Centres connected to 57 super specialty hospitals located in major cities. Seventeen mobile telemedicine units are also part of this network.[93]

ISRO's Initiative in Telemedicine[94]

ISRO initiated Telemedicine programme in 2001 as a special programme, for providing;

- Telehealth to the un-served and the under-served
- Set up Telemedicine facilities in distant and rural of India to supplement the general healthcare infrastructure.

Efforts by ISRO [92,95]

- Space based Rural Development Programmes since 1990s
- Major thrust for TM as a special programme since 2001
- Spearheading the Telemedicine movement in India with the largest network and continuous improvement

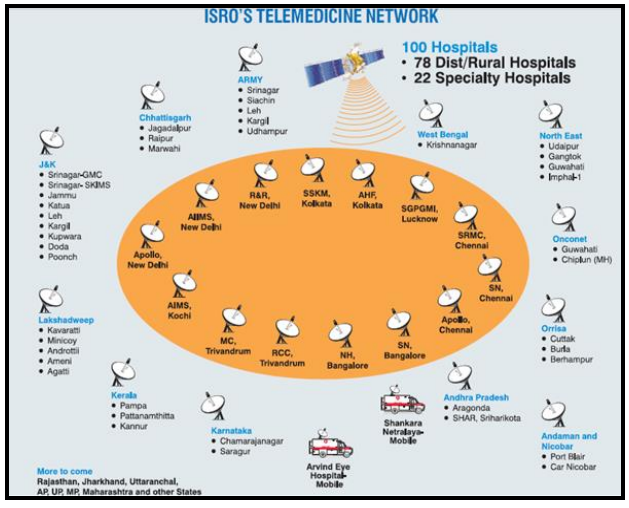

Figure 7: ISRO's Telemedicine netwwork[97]

Telemedicine Initivatives[96]

Beginning with ISRO's Telemedicine pilot project of 2001, the telemedicine network in India has treated more than 25,000 patients. Presently, ISRO's telemedicine network stretches to around 100 hospitals all over the country with 78 remote/rural/district hospitals/health centres connected to 22 specialty hospitals located in the major cities.

Many states have come forward to introduce telemedicine on a regular operational basis and have planned to equip all the district hospitals with telemedicine facility both for ambulatory & intensive care treatment. Karnataka, Chattisgarh, Kerala and Jarkand are some of the states which have initiated the establishment of satellite based telemedicine facility for all their district hospitals and a few trust hospitals. This will soon be followed by other states too.

As a result of ISRO's telemedicine endeavour, remote areas like Kargil and Leh in the North, offshore islands of Andaman and Nicobar and Lakshwadeep, as well as some of the interior parts of Orissa, Karnataka, Kerala, Chattisgarh, J&K, North-eastern states of India and some tribal districts in certain other states have access to specialty healthcare from some of the major specialty hospitals in the country today.

Continuing Medical Education[96]

Under ISRO's telemedicine programme, Continuing Medical Education (CME) efforts provide doctors at rural healthcare centres a chance to upgrade their medical knowledge and skills through interactions with experts at the specialty hospitals through satellite based tele-link. Such interactions indirectly result in significantly enhancing the quality of healthcare available to rural patients. The Continuing Medical Education programme has been integrated with the tele-education programme by linking some of the medical institutions with the specialty hospitals and research centres.

Mobile Telemedicine[96]

'Mobile Telemedicine Unit' consisting of medical equipment along with telemedicine hardware, software and VSAT system mounted

in a Bus/Van can establish a mobile telemedicine centre at any place.

The major area of mobile telemedicine applications are in the field of tele ophthalmology and community health. Under mobile tele-ophthalmology, rural eye camps can be conducted and the rural population can undergo eye screening for cataract, glaucoma and diabetic retinopathy. Under community health program, mobile telemedicine units are very useful not only for disease prevention but also for health promotion in terms of running awareness camps & teaching hygienic practices.

Village Resource Centres and Telemedicine[96]

Recently, ISRO has also initiated pilot projects for integrating Telemedicine/Tele-health with the Resource Information database as well as Tele-Education facilities at the Village Resource Centres/Community Centres (VRC) to reach out to more rural areas of the country. The first of the pilot projects has been implemented in the state of Tamil Nadu wherein the nodal centre operated by an NGO agency at Chennai is connected to remote villages in three districts and more are to come in the future.

One of the major advantages of telemedicine technology has been the saving of cost and effort to the rural patients as they are not required to travel long distances for obtaining consultation and treatment. A study conducted by an independent agency on one thousand patients in the Chamarajanagar district hospital in Karnataka has revealed that there was a cost saving of 81% to the patient. That is, the patients who availed the telemedicine consultation and treatment spent only 19% of the money which they would have otherwise spent if they had to travel to the nearest cities for a similar treatment.

In the case of remote offshore islands, this is much more significant both to the patient and the government administration. In such cases, not only the patients have the cost saving but can be provided with quick and timely medical aid.

Telemedicine for Special Situations[96, 97]

Telemedicine connectivity has been provided every year since 2002 at Pampa, at the foothills of Sabarimala shrine in Kerala where lakhs of pilgrims visit the shrine. Here the telemedicine connectivity is provided between the Temple Board Hospital at Pampa and Amrutha Institute of Medical Sciences, Kochi and Trivandvam Medical College Hospital.

Several pilgrims availed the facility and some lives were saved. Similar efforts will be made for other places also.

Telemedicine during Tsunami

The ISRO's telemedicine facilities at three hospitals – GB Pant Hospital, INHS Dhanvantari at Port Blair, Andaman Island and Bishop Richardson Hospital at Car Nicobar along with ISRO Gramasat Network at 8 Islands was effectively used during post Tsunami disaster relief work for the benefit of the remote population of Andaman and Nicobar Islands. More such telemedicine centres are being planned at the primary health centres of various islands of Andaman and Nicobar.[96]

Ministry of Health & Family Welfare (MoH&FW)[97]

MoH&FW has implemented Integrated Disease Surveillance Programme network which connect all district hospitals with medical colleges of the state to facilitate tele-consultation, tele-education/ training of health professionals and monitoring disease trends. It has funded few pilot national level tele-ophthalmology and rural telemedicine projects.

State Governments of various states of India[96]

Various states, now realizing the advantages and benefits of telemedicine technology in modern day healthcare delivery, took initiatives to establish state wide telemedicine networks to strengthen the healthcare facilities in their states. The governments of Orissa and Uttarakhand have networked their secondary level hospitals and then linked them to SGPGIMS, Lucknow for specialty consultation.

The Governments of Jammu and Kashmir, Chhattisgarh, Rajasthan, Karnataka, Jharkhand, Kerala with the support of ISRO and state of Himachal Pradesh**,** Punjab, North Eastern states, West Bengal, Tamilnadu with the support of DIT has established state wide network linking state Government Medical Colleges and district hospitals.

Academic Medical Institutions and Corporate Hospitals

SGPGIMS, Lucknow a premier institution in public sector adopted IT in the form of hospital information & management systems and started its telemedicine activities in 1999 with the support of various government agencies. It has networked 24 national and international partner nodes and has been carrying out tele-education and tele-healthcare activities and has developed various modules for these activities.[96] Two other premier institutions of India viz. AIIMS, New Delhi (Jammu & Kashmir, Haryana, Orissa, North Eastern states network) and PGIMER, Chandigarh and Sri Ramachandra Medical College and Research Institute , Chennai (35 nodes), Tata Memorial Hospital, Mumbai (30 nodes) Christian Medical College, Vellore are also involved in similar activities.

In the corporate sector, the major players are Apollo Hospital Group (64 nodes), AIMS (23 nodes), Kochi, Asia Heart Foundation (tele-cardiology & mobile van), Bangalore, Fortis Hospital (27 nodes), Narayana Hrudayalaya (55 nodes) and Escorts Heart Institute and Research Center (17 nodes). Sir Ganga Ram Hospital (SGRH), New Delhi has launched its telemedicine centers in Haryana and Rajasthan states.

Mobile Telemedicine

With the support of ISRO, Shankar Nethralaya at Chennai, Meenakshi Eye Mission and Aravind Eye Hospital Madurai and four other corporate eye hospitals have launched Mobile Tele-ophthalmology service for early diagnosis and treatment of ophthalmic diseases under National Blindness Control Program. SGRH, AIMS, SRMC, and AHF have launched mobile Tele-hospitals for rural access of specialty healthcare services.[96]

Global Telemedicine Projects initiated by Ministry of External Affairs, Government of India[98]

South Asian Association for Regional Cooperation (SAARC) Telemedicine Network

The preparatory work for a pilot project connecting one/two hospitals in each of the SAARC countries with the super specialty hospitals that include AIIMS, New Delhi; SGPGIMS, Lucknow; PGIMER Chandigarh and CARE Hospital, Hyderabad of India. Jigme Dorji Wangchuck National Referral Hospital, Thimphu, Bhutan and Indira Gandhi Child Hospital, Kabul, Afghanistan have been connected to SGPGIMS, Lucknow and PGIMER, Chandigarh under this project for tele-education and tele-healthcare activities.[98]

Pan-African eNetwork Project

The MEA is implementing this project through Telecommunications Consultants India Ltd. (TCIL) to establish a VSAT based infrastructure for 53 African countries of the African union by a satellite and fiber optic network that would provide effective Tele-Education, Tele-Medicine, Internet, Videoconferencing and VoIP services. Ten super specialty hospitals in India have been identified to provide telehealth services to 53 remote African hospitals.[98]

E-Learning in Health Sector[99]

Online Open Access Bibliography

Two government agencies, National Informatics Center (NIC) and Indian Council of Medical Research (ICMR), have established the Indian Medical Literature Analysis and Retrieval System (MEDLARS) Center to cater the information needs of medical community of India.[99]

Collaborative Knowledge Sharing through Telemedicine Network

Premier academic medical institutions of India are actively involved in sharing their academic activities over the telemedicine network.[99]

National Digital Medical Library Consortium

National Medical Library's Electronic Resources in Medicine (ERMED) Consortium is an initiative taken by Director General of Heath Services (DGHS) to develop nationwide electronic information resources in the field of medicine. 76 centrally funded Government Institutions including 10 under DGHS, 28 laboratories of Indian Council of Medical Research and AIIMS libraries are selected at the initial stage as its core members. The MoH&FW aims to provide fund required for the purchase of electronic journals under this consortium project.[99]

Medvarsity

Apollo Hospitals Group in association with NIIT Ltd has launched Medvarsity to provide the platform for online delivery of continuing medical education and offer variety of courses for doctors, nurses and other paramedical personnel.[99]

Future Perspective of Telemedicine in India[99,100]

The GoI is planning and implementing various national level telemedicine projects and deploying mobile and fixed tele-centers within the country to provide health care facilities to the remotest and poorly accessible areas of the country. ISRO' telemedicine nodes are expanding and are also planning to launch dedicated satellite HEALTHSAT for healthcare delivery. Encouraged by the success of Kerela ONCONET project by DIT, MoH & FW is planning to implement 'OncoNET India' project which will network 27 Regional Cancer Centres with 100 Peripheral Cancer Centers to facilitate National Cancer Control Program and 'National Rural Telemedicine Network (NRTN)' project under National Rural Health Mission. Another project in the field of e-learning is 'National Medical College Network Project' to establish a national grid of telemedicine for networking of medical colleges. Few tertiary care academic medical institutes from different regions of the country will be identified as Medical Knowledge Resource Centres (Regional Hub), each of which will be connected to medical colleges (Nodes) in that region. One of these regional hubs will be identified as the Central Hub which will be overall responsible to co-ordinate the National Network in addition to provide infrastructure for Central Content Development Centre. DIT is putting efforts in developing School of Telemedicine and Biomedical Informatics into National Resource Center for telemedicine. It is planning to launch various other projects in collaboration with other government organizations such as Development of a Web Based Telemedicine System for chronic diseases, E-Health visualization and E-Health associated field, advanced ICT for health care proof of concept project in district by NIC state center, Hyderabad and access to quality healthcare in Tamil Nadu through a pilot telemedicine network. National Knowledge Commission which is a high-level advisory body to the Prime Minister of India, with the objective of transforming India into a knowledge society, are planning to develop Indian Health Information Network.[100]

The Future ISRO's telemedicine endeavour is expanding its outreach and has the potential to open up new frontiers for facilitating rural healthcare in India.

Encouraged by the steady growth of its telemedicine programme, ISRO has also envisioned the development of "HEALTHSAT", an exclusive satellite for meeting the healthcare and medical education needs of the country at large. This satellite, when deployed along with wireless and terrestrial communication links, can bring a large change in augmenting the present healthcare delivery system in the country. Due to the untiring efforts of various departments like the Department of Space and the Department of Information Technology, State Governments, NGOs and Private and Corporate Hospitals/Agencies, the majority of the rural population all over the country will stand to benefit from telemedicine technology that can usher in a revolution for transforming the face of healthcare in India.[100]

Thus, telemedicine can enlarge the gap between life and death and can extend quality healthcare to the needy and the under privileged rural, semi rural and urban population at large.[100]

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