Telemedicine in India

By
Pruthvi Chaudhari
EE244 Class Project
Professor Bruce Lusignan

Stanford University
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Introduction

Today, majority of population in developing countries still lives in rural areas while the majority of medical community exists in the urban cities. The rural population suffers from a burden of disease and disorders primarily due to the non-availability of appropriate healthcare personnel and facilities. In rural India, there is preponderance of certain health problems, such as a high suicide rate, incidences of certain types of mental health problems associated with the physical nature of work in local industries.

India is geographically large with many towns and villages located in remote rural areas. Few medical facilities exist to serve the large population that resides in the villages. India has 80% of its main health-care centers located in the cities that host only 30% of the total population. Percentage-wise, 80% of the Indian population is served by only 20% of doctors. Due to this, rural communities are at far greater disadvantages such as late discovery of ailment, transport time to urban health-care facilities and inexperienced primary health-care providers in rural areas. In most cases, rural patients are sent or they willingly visit hospitals in highly developed (urban) areas at considerable expense.

Today, personal computers, scanners, digital cameras, and many peripherals are available at relatively low costs. Combining them with appropriate software and telecommunications will enable transfer clinical data from one part of the world to any other part. Offering medical advice remotely, using state-of-the-art tools, is now a regular feature in several parts of the world—including the United States. This way of treating patients is now referred to as "Telemedicine." Telemedicine relies on the transfer of text, reports, voice, images and video between geographically separated locations.

With this new methodology, patients can be examined, investigated, monitored, and treated with the patient and the doctor in different places. Here, transfer of expertise has occurred instead of the patients to other locations. A major goal of telemedicine is to eliminate unnecessary traveling of patients and their escorts. Image acquisition, image storage, image display and processing, and image transfer represent the basis of telemedicine. It is becoming an integral part of health care services in several countries including the United Kingdom, the USA, Canada, Italy, Germany, Japan, Greece, and Norway and now in India. Several studies have shown telemedicine to be practical, safe and cost effective. Telemedicine hinges on transfer of text, reports, voice, images and video between geographically separated locations. A major goal of telemedicine is to eliminate unnecessary traveling of patients and their escorts. Image acquisition, image storage, image display and processing, and image transfer represent the basis of telemedicine.

Rural India Case

Currently, there are 620 million people live in rural India. The doctor-patient ratio in the country is on doctor for every 2,000 persons (for comparison, in the USA it is 1:400), and most specialists are concentrated in towns and cities. About two million bends are required as against 0.7million available. Only 9% of 1.08 billion people are covered by health schemes.

The Indian rural population has a higher proportion of elderly people compared with the national average. Abuse of alcohol and the use of smokeless tobacco is a significant problem among rural youth. Rural hospitals are half as likely to provide emergency mental health care as are urban hospitals. Rural residents have greater transportation difficulties for health care compared with urban residents and this is particularly so for vulnerable groups such as the elderly or disabled persons. Rural residents have difficulties accessing food retailers for fresh fruit and vegetables which has implications of diet-linked diseases. Rural hosing difficulties associated with the limited supply of low cost housing and the poorer quality of housing in rural areas maybe associated with homelessness, asthma and respiratory infection, and certain other infections such as tuberculosis. Unemployment is higher in rural areas and linked with limited employment opportunities, seasonal and part-time work, low wages, decline in agricultural labor force and work-related stress and risk. Some villages have a medical facility available but few doctors are willing to accept posts in these rural hospitals. Doctors who do work with rural patients may be professionally isolated and lack the opportunity for continuing education.

Overview of Telemedicine Infrastructure

Positive changes in the public policy on infrastructure and sponsorship have improved the feasibility of telemedicine adoption and implementation. Since the infrastructure is largely owned by the government, telemedicine initiatives are constrained by existing state-sponsored networks, varying only in terms of equipment and software applications. The popularity of wireless and India's home-grown satellite technologies developed by Indian Space Research Organization (ISRO) offers critical infrastructure to support tele-applications. The INSAT satellite system establish in 1983 created one of the world's largest domestic communication systems with seven satellites and 130 *C*-band transponders linking many hundred earth stations in remote and rural areas along with thousands on very small aperture terminals (VSAT). The infrastructure enables the country to reach over 65% of the Indian landmass and 80% of its population. The technical infrastructure for such projects is shown in Figure 1.

At the lowest level, there are telemedicine technicians housed in solar-powered mobile tele-centers equipped with portable workstations for recording and transmitting objective medical information (electrocardiogram, blood pressure, heart rate, and etc.). The next level facilities are either mobile or semi-permanent structures containing the following equipment: a medical processing unit with necessary client software for image acquisition, processing, compression and transfer a pathological microscope; medical image digitizer; an ECG machine; X-ray machine; a camera for videoconferencing; and angiography convertible software. The output (fed through a web-camera) is captured, compressed, and transmitted using a medical data and image distribution client which provides a web-server and a user-friendly client interface for collating medical data and images for easy transfer.

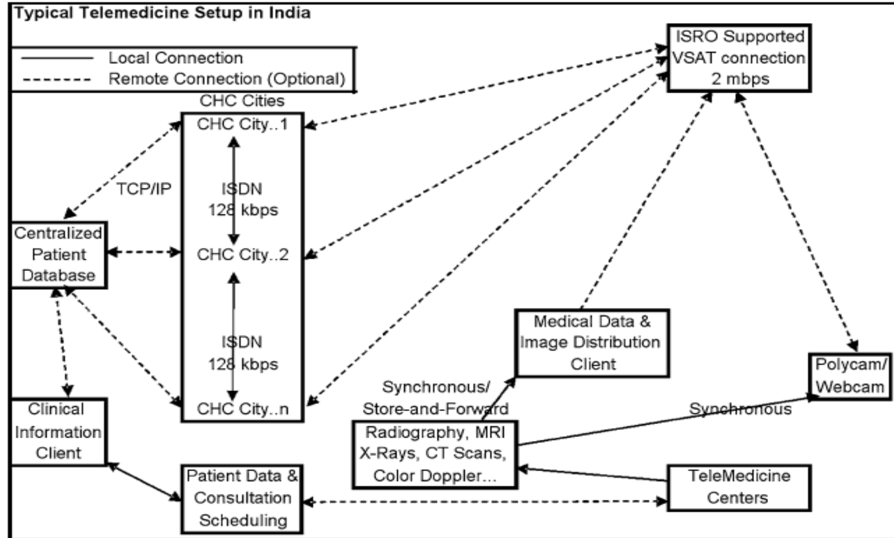

Figure 1: Typical Telemedicine Setup in India

Today, wireless telephony and satellite networks allow data transfers from conventionally inaccessible sites. For example, with VSAT, mobile cellular systems are used to link cellular technology to low-Earth-orbit satellites through a user mobile link that then communicates with earth stations. In absence of landlines, these gateway link provide communications between remote telemedicine facilities and the community health centers (CHCs). The CHCs, located in major Indian cities, are connected via Integrated Services Digital Network (ISDN), with a redundant backup VSAT channel open.

Typical Procedure

Once a patient arrives at a telemedicine facility, the technician is informed of the patient's condition. The facility enters patient data into clinical-management software that allows maintenance, access, and transfer of clinical records. The clinical records are stored in a centralized database running on a secure server. Data transfers are made through the software's web interface. The software application stores images, provides hospital and referral information, schedules visitation, maintains account and clinical data. Once patient records and history are entered and updated, a consultation is requested and a series of preliminary diagnostic tests are performed using available telemedicine equipment. Patient data is digitized and fed into the patient/image distribution client that is linked to the clinical-management software for scheduling remote consultations.

Cost

Most telemedicine services are free and aimed toward remote, underprivileged population with little or no access to necessary health care. For the rest, a nominal charge is stipulated to reconcile the marginal costs of communication and equipment maintenance. Installation costs per telemedicine unit are about $30,000, which is very high by Indian standards. The Indian government has stepped into subsidize upcoming telemedicine ventures and defray end-user

costs. In addition, ISRO's upcoming Telemedicine satellites are expected to reduce installation costs from $30,000 down to $10,000 per facility.

Specific Cases of Telemedicine Projects

Recently, a few organizations have successfully executed telemedicine projects in rural India. Listed below are brief descriptions of such projects.

Apollo Hospitals. The Apollo Hospitals system, founded in 1987, has become one of the Asia's largest private health-care groups and the seventh largest in the world. The project has opened remote telemedicine centers that link villagers via satellite to specialist services. Table I shows the infrastructure and services.

Table 1: Apollo Hospitals [Ref 3]

Organization	Apollo Hospitals
Program Name & Inception	Apollo Telemedicine Enterprises Limited; 1999
Locations (States)	South India (Tamil Nadu, Andhra Pradesh), North India (Delhi), and East India (Orissa, Assam, Nagaland, West Bengal)
Health Network	Hospital (Private and Public), Outpatient Clinics, Military Bases
Application Orientation	Cardiology, Dermatology, Emergency, Radiology, Rheumatology, Nephrology, General Consulation
Non-Clinical Activities	Health Education, Web development, Research, and Administration
Number of Sites	45
Content Delivery	Telephone, Interactive with still and video images, Store and forward
Equipment	PC and Standalone Video-Conferencing, TeleRadiology System, Home Care Units
Peripherals	BP Monitor, Spirometer, Ultrasound, Tele-ECG, Digital Camera, Stethoscope, Glucometer, Document Camera
Connectivity	POTS/Wireless/VSAT/ISDN
Sponsors	Indian Government, ISRO, GE, Wipro

Apollo's Aragonda project was India's first rural telemedicine station. Aragonda is typical of other Indian villages. With the Aragonda project, the village was connected to the Apollo hospitals in Chennai bringing tertiary care to the doorsteps of patients.

2. Online Telemedicine Research Institute (OTRI, State of Gujarat). OTRI heralded a new era of expertise by starting the first ever statewide telemedicine network in India under the "Gujarat Telemedicine Network" project. Table II below provides an overview of OTRI's infrastructure and sevices. OTRI has operation centers in several states with application development and equipment manufacturing capabilities. The institute has also introduced a health card which allows entire families to have complete physical examinations at a minimal cost without having to travel far to consult specialists. This project made an enourmous impact on the lives of people living in north-western part of Gujarat. On January 27, 2001 an earthquake devastated the city of Bhuj and left thousands dead and many more homeless. Within a day, the OTRI in Ahmedabad, about 300km from Bhuj, established satellite telephone links and set up all the equipment necessary to provide emergency medical care through telemedicine. The satellite phones were soon replaced by VSAT with phone lines and ISDN, and much of the imaging and data transfer were mediated by Pentium III based personal computers.

Table 2: OTRI Profile [Ref 2]

Organization	Online Telemedicine Research Institute (OTRI)
Program Name & Inception	Gujarat TeleMedicine Network (GTN) Project; 1998
Locations (States)	West India (Gujarat, Mahrashtra), South India (Karnataka), East India (Assam, Tripura, West Bengal), and North India (Uttar Pradesh)
Health Network	Private Hospitals, 225 Online Tele-Hospitals, Mobile Clinics, Military Bases
Application Orientation	Cardiology, Radiology, Pathology, Opthalmology, Nephrology, General Consulation
Non-Clinical Activities	Health Education, Web development, Telemedicine Systems Development, Research, Disaster Management, and Administration
Number of Sites	> 200
Content Delivery	Telephone, Interactive with still and video images, Store and forward
Equipment	PC and Standalone Video-Conferencing
Peripherals	BP Monitor, Ultrasound, Tele-ECG, Digital Camera, Stethoscope, Event Recorder, PTZ Camera,
Connectivity	POTS/Wireless/VSAT/ISDN
Sponsors	ISRO, Indian Government, Industry

3. Asia Heart Fondation. This is a non-profit charitable organization established with the objective for providing cardiac care to the general populace. The telemedicine initiative "Integrated Telecardiology and Telehealth Project" (ITTP) aims at taking cardiac care to the nation's deprived rural and remote population, thereby bringing the critical knowledge gap in cardiac care services provided in rural and metry areas. All of ITTP's telemedicine units are linked to its centers in Calcutta and Bangalore. Several state governments provide the basic infrastructure and the Foundation's doctors do all treatments. The Foundation uses innovations in information and communication technologies including space technology and VSATs developed by the ISRO.

Table 3: Asia Heart Foundation

Organization	Asia Heart Foundation
Program Name & Inception	Integrated Telemedicine and Telehealth Project; 1999
Locations (States)	North-East (Assam) and South India (Karnataka)
Health Network	Hospital (Private and Public)
Application Orientation	Cardiology, Pediatrics, Public Health, General Consulation
Non-Clinical Activities	Health Education, Research, and Administration
Number of Sites	18
Content Delivery	Telephone, Interactive with still and video images, Store and forward
Equipment	PC-Based Video-conferencing and Webcam
Peripherals	ECG, Event Recorder, Scanner
Connectivity	POTS/VSAT/ISDN
Sponsors	Indian Government, ISRO

Disadvantages

The advantages of telemedicine are quite clear from the reviewed research in this article. It makes health care more accessible to rural communities, video consultation eliminate the prohibitive travels from rural to urban areas, and the problem of insufficiency in doctors

practicing in rural areas is also addressed and solved. The building of a telecommunications infrastructure presents a vehicle for a disease surveillance and response at the district, state and national level. There are, however, disadvantages to this new approach. There are now increased expectations of health care, physician license issues, resistance to the technology and the costs associated with installation. For an all-India telemedicine system to be successful, state licensing of physicians must be revised (all specialists being registered in at least 20 states in order to treat patients) and re-formulated for ease of obtaining registration. Until there is widespread acceptance of the technology, patient and physician resistance may be expressed in fear of malpractice suits due to lack of "hands-on" interaction with patients. Among barriers to the practice, the cost of installation, including hardware and infrastructure is one of the greatest. To overcome this, installation should be staged. Once the system is installed, the cost of operation is low in terms of ongoing input, manpower and capital costs. Many telemedicine projects have been hampered by the lack of appropriate telecommunications technology. Regular telephone lines do not supply adequate bandwidth for most telemedical applications, and few rural areas have the cable wiring required for telemedicine. Once a telemedicine system is in place, a radical change is forecast and transition from the current grant- and self-funded projects, to a major self-sustaining industry within the healthcare field.

Conclusion

Telemedicine has and continues to benefit the Indian health-care system in terms of preventive care and disease treatment. Several technology companies (Tata Consultancy Services, Wipro, Tata Unisys) are in the process of providing the telecommunication support needed for telemedicine, but much remains to be accomplished before telemedicine can reap its touted benefits for India's exponentially growing population. Given proper access and awareness, India seems poised to incorporate telemedicine beyond its current rudimentary projects to large-scale programs that can serve as a model for itself and the developing world.

Reference

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