Telemedicine in India: Current Scenario and the Future


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Abstract
India, with its diverse landmass and huge population, is an ideal setting for telemedicine. Telemedicine activities were started in 1999. The Indian Space Research Organization has been deploying a SATCOM-based telemedicine network across the country since that year. Various government agencies—Department of Information Technology and Ministry of Health & Family Welfare, state governments, premier medical and technical institutions of India—have taken initiatives with the aim to provide quality healthcare facilities to the rural and remote parts of the country. The Government of India has planned and implemented various national-level projects and also extended telemedicine services to South Asian and African countries. Efforts are taking place in the field of medical e-learning by establishing digital medical libraries. Some institutions that are actively involved in telemedicine activities have started curriculum and noncurriculum telemedicine training programs. To support telemedicine activities within the country, the Department of Information Technology has defined the Standards for Telemedicine Systems and the Ministry of Health & Family Welfare has constituted the National Telemedicine Task Force. There are multiple players but no single source of information.

Key words: telemedicine, tele-education, standardization, policy, capacity, human resource

Introduction
The triangular Indian peninsula holds every kind of landscape spread over an area of 3 million square kilometers and having a population of more than 1 billion across 29 states and six union territories governed by a federal system. Government-supported healthcare delivery follows a three-tier system and is a 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. Furthermore, healthcare delivery is difficult in the inhospitable geographical terrain such as mountain regions in the northeast, deserts of the northwest, and the off-shore islands of Andaman and Lakshadweep. The potential of telemedicine technology in providing healthcare access to rural populations and far-flung areas has long been realized, and many technical ministries of the Government of India such as Information Technology, Science & Technology, and Space have been experimenting with telemedicine pilot projects since early 2000. Based on the successful outcome of these pilots, the Ministry of Health and Family Welfare has now adopted telemedicine into the National Rural Health Mission, an initiative focused on improvement of the rural healthcare delivery system. All across the country, several telemedicine initiatives have been taken up by both government and private sector organizations with federal and state funding. Some have adopted a few modules into their health system.

Materials and Methods
Information on various aspects of telemedicine in India such as major projects sponsored by different ministries of Government of India, activities undertaken by healthcare and academic organizations, standardization and policy initiatives, scientific publications and organizational activities, human resource development, industry, and so on constitute the material for compilation of the country report. There are multiple players but no single source of informa-
tion. To collect information on all these categories of telemedicine programs around the country, we utilized various methods and tapped multiple sources. We used our personal knowledge and communication and frequently visited the Web sites of various ministries and organizations of Government of India, several academic and corporate medical institutions, telemedicine vendors, reviewing abstract books of telemedicine meetings, and conferences held in India and scientific publications retrieved from PubMed (www.pubmed.com). We e-mailed and phoned our colleagues working in other government and medical organizations to get information on their telemedicine activities. All these information were compiled and analyzed and the synthesis is presented here.

**Results**

The synthesized information on current telemedicine programs across the country, upcoming national initiatives, policy, and so on are grouped into following categories.

**PILOT PROJECTS SUPPORTED BY CENTRAL MINISTRIES OF GOVERNMENT OF INDIA (GOI)**

The major initiative in establishing several telemedicine nodes all over the country is steered by the Department of Information Technology (DIT), Ministry of Communications and Information Technology, and the Indian Space Research Organization (ISRO) in collaboration with the state governments, various premier technical, and medical institutions of the country.

**DEPARTMENT OF INFORMATION TECHNOLOGY, MINISTRY OF COMMUNICATION, AND IT**

Some of the successful telemedicine pilot projects implemented by DIT in various states are the telemedicine network in West Bengal for diagnosis and monitoring of tropical diseases, the Oncology Network in Kerala and Tamil Nadu, the network for specialty healthcare access in rural areas in Punjab, Maharashtra, the hilly state of Himachal Pradesh, and the North-Eastern region. DIT also established links among the three premier institutions, namely, The Sanjay Ghandi 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’s satellite-based Telemedicine network through Indian Satellite System (INSAT), which started in 2001 under the GRAMSAT (rural satellite) program now includes 315 hospitals: 271 remote/rural district hospitals/health centers connected to 44 superspecialty hospitals located in major cities. Ten mobile tele-ophthalmology units are also part of this network. This has been implemented in the remote areas of northeastern states of Tripura, Nagaland and in the southern

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*Fig. 1. Geographic distribution of telemedicine nodes in the India map.*
state of Karnataka in its tribal belt. District hospitals of Andaman and Nicobar Islands are linked to specialty hospitals in mainland India.

MINISTRY OF HEALTH & FAMILY WELFARE (MOH&FW)
MoH&FW has implemented Integrated Disease Surveillance Project networking of all district hospitals with medical colleges of the state to strengthen the public health system, particularly focusing on disease surveillance. It has now adopted telemedicine into the National Rural Health Mission, aiming at providing healthcare access to the rural population, National Rural Telemedicine Network (NRTN) Project, and has launched tele-ophthalmology pilot projects in many states under the National Blindness Control Program.

State Governments of India
Various states, now realizing the advantages and benefits of telemedicine technology in modern-day healthcare delivery, are cooperating with the central government in establishing statewide telemedicine networks to strengthen the healthcare facilities in their states. Some have also started owning the projects and integrating them into their health system. Detailed state information is provided in Figure 1 and Table 1.5–11

Academic Medical Institutions and Corporate Hospitals
SGPGIMS,12 a premier academic institution in the public sector, started telemedicine activities in 1999 with funding support from various government agencies.13 The institute is now networked with 24 national and international partner institutions and has been carrying out tele-education and telehealth activities. Various departments have integrated telehealth and tele-educational services. Two other premier institutions of India, the AIIMS,14 New Delhi (linked with hospitals in Jammu and Kashmir, Haryana, Orissa, and North Eastern

Table 1. Statewide Telemedicine Network Implemented in Various States of India

<table>
<thead>
<tr>
<th>NAME OF THE STATE GOVERNMENT</th>
<th>FUNDING AGENCY</th>
<th>NO. OF TELEMEDICINE NODES</th>
<th>SPECIALTY HOSPITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jammu and Kashmir</td>
<td>ISRO</td>
<td>12 District hospitals</td>
<td>Sher-e-Kashmir Institute of Medical Sciences Hospital, Srinagar</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>DIT</td>
<td>19 Health centers at district, block, and tehsil headquarters</td>
<td>IGMC Shimla and PGIMER Chandigarh</td>
</tr>
<tr>
<td>Punjab</td>
<td>DIT</td>
<td>20 District hospitals</td>
<td>Government medical college and hospital and five polyclinics of the state</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>State</td>
<td>2 District hospitals</td>
<td>SGPGIMS, Lucknow</td>
</tr>
<tr>
<td>North Eastern States</td>
<td>DIT</td>
<td>District hospitals each of seven North eastern states</td>
<td>Narayana Hrudayalaya, Bangalore</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>ISRO</td>
<td>22 District hospitals</td>
<td>3 Medical colleges &amp; hospitals</td>
</tr>
<tr>
<td>West Bengal</td>
<td>DIT</td>
<td>12 District hospitals</td>
<td>School of Tropical Medicine, NRS Medical College &amp; Hospital, Kolkata, Burdwan Medical College &amp; Hospital, Burdwan</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>ISRO</td>
<td>32 District hospitals</td>
<td>6 State medical colleges</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>ISRO</td>
<td>Two at medical colleges</td>
<td>Government medical colleges at Raipur &amp; Bilaspur that further link to premier hospitals of the country</td>
</tr>
<tr>
<td>Orissa</td>
<td>ISRO, C-DAC</td>
<td>5 District Hospitals</td>
<td>3 Medical colleges that further linked with SGPGIMS</td>
</tr>
<tr>
<td>Karnataka</td>
<td>ISRO</td>
<td>26 District hospitals</td>
<td>Narayana Hrudayalaya, Bangalore</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>ISRO</td>
<td>6 District hospitals</td>
<td>Government General Hospital, Royapettah Hospital, Adyar Cancer Center—all at Chennai</td>
</tr>
<tr>
<td>Kerala</td>
<td>ISRO, C-DAC</td>
<td>14 District hospitals and two taluk hospitals</td>
<td>AIIMS, New Delhi, Amrita Institute of Medical Sciences (AIMS), Kochi, and Sri Chithira Tirunal Institute of Medical Science and Technology, Thiruvananthapuram</td>
</tr>
</tbody>
</table>

ISRO, Indian Space Research Organization; DIT, Department of Information Technology; PGIMER, Post Graduate Institute of Medical Sciences; SGPGIMS, Sanjay Ghandi Postgraduate Institute of Medical Sciences.
states) and PGIMER, Chandigarh (linked with 20 district hospitals of Punjab and Himachal states) have been leaders in telemedicine programming and dissemination. Sri Ramachandra Medical College (SRMC), Chennai (linked with 35 national and international nodes), Tata Memorial Hospital, Mumbai (linked with 30 nodes) Christian Medical College, Vellore are also involved in similar activities. In the corporate sector, the major players are the Apollo Hospital Group (linked with 64 nodes), Amrita Institute of Medical Sciences (AIMS), Kochi (linked with 23 nodes), Asia Heart Foundation (AHF), Bangalore (telecardiology and mobile van), Fortis Hospital, New Delhi (linked with 27 nodes), Narayana Hrudyalaya, Bangalore (linked with 55 nodes), and Escorts Heart Institute and Research Center (linked with 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 Aravinda Eye Hospital at Madurai and four other corporate eye hospitals have launched mobile teleophthalmology service for early diagnosis and treatment of ophthalmic diseases under National Blindness Control Program. SGRH, AIMS, SRMC, and AHF have launched mobile telehospitals for rural access of specialty healthcare services. Andhra Pradesh state government has launched mobile clinics that would daily visit two villages to check health parameters of people and also carry out telemedicine through “104 services.” In Maharashtra, BPL Mobile has launched the value-added service to provide a virtual channel that will give subscribers instant access to quality medical assistance, real-time interaction with doctors anytime and anywhere. Gujarat government’s health department has announced an e-medicine scheme for rural areas.

Global Telemedicine Projects Initiated by India

The Ministry of External Affairs (MEA) has undertaken a global telemedicine initiative in Africa and South Asia to extend its telemedicine-enabled healthcare and educational services under a South Asian Association for Regional Cooperation (SAARC) and Pan-African e-Network Project.

SAARC Telemedicine Network

The SAARC, created as an expression of the region’s collective decision to evolve a regional cooperative framework, received a major impetus during the 14th SAARC Summit held in New Delhi in April 2007. The preparatory work for a pilot project connecting one or two hospitals in each of the SAARC countries with the superspecialty hospitals that include AIIMS, New Delhi; SGPGIMS, Lucknow; PGIMER Chandigarh and CARE Hospital, Hyderabad of India has been complete. Jigme Dorji Wangchuck National Referral Hospital, Thimphu, Bhutan has been connected to SGPGIMS, Lucknow and PGIMER, Chandigarh under this project, which was inaugurated in April 2009.

Pan-African e-Network Project

The MEA is implementing this project through Telecommunications Consultants India, Ltd. (TCIL) to establish a VSAT infrastructure for 53 African Countries of the African Union by a satellite and fiberoptic network that would provide effective tele-education, telemedicine, Internet, videoconferencing, and voice over Internet Protocol services. Ten superspecialty hospitals in India have been identified to provide telehealth services to 53 remote African hospitals.

e-Learning in the Health Sector

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 to the information needs of the medical community of India. This ICMR-NIC Center for Biomedical Information has developed various Web-based modules such as a union catalogue of journal holdings of medical libraries of India (http://uncat.nic.in), a bibliographic database of Indian biomedical journals (http://indmed.nic.in), and full texts of Indian biomedical journals (http://medind.nic.in).

COLLABORATIVE KNOWLEDGE SHARING

Toward professional knowledge sharing, premier academic medical institutions, namely, AIIMS, New Delhi, PGIMER, Chandigarh, SGPGIMS, Lucknow, Christian Medical College (CMC), Vellore and AIMS, Kochi are actively involved in sharing their academic activities over the telemedicine network.

NATIONAL DIGITAL MEDICAL LIBRARY CONSORTIUM

National Medical Library’s Electronic Resources in Medicine Consortium is an initiative taken by the Director General of Health Services (DGHS) to develop nationwide electronic information resources in the field of medicine. Seventy-six (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 MoHFW aims to provide funds required for the purchase of electronic journals under this consortium project.
MEDVARSITY
Apollo Hospitals Group, in association with NIIT Ltd., has launched Medvarsity to provide the platform for online delivery of continuing medical education and offers variety of courses for doctors, nurses, and other paramedical personnel.35

Education and Training in e-Health Toward Capacity Building
SCHOOL OF TELEMEDICINE AND BIOMEDICAL INFORMATICS
SGPGIMS, Lucknow, with funding support from Uttar Pradesh State government, has set up a School of Telemedicine and Biomedical Informatics on its campus.36 The objectives of the School are creation of various resource facilities, conduct-structured training programs, research and development, and providing consultancy to government and private healthcare organizations in collaboration with technical and medical universities in the country and abroad. This School is being identified as a National Resource Center for Telemedicine by DIT.37 It is also involved in developing various low-cost telemedicine products. The school has received trainees not only from within the country but also from abroad and is going to start curriculum-based telemedicine courses very soon.

The Apollo Telemedicine Network Foundation, in collaboration with Anna University, Chennai, has started a 15-day certificate course in telehealth technology that is a blend of technical, medical, and managerial skills.38

RAD GURUKUL
Solutions, premier provider of teleradiology services, launched “Rad Gurukul,” the teleradiology training center in Bangalore, to provide training and to refine the skills of radiologists, technologists, and IT personnel involved in healthcare IT.39

C-DAC MOHALI
C-DAC Mohali provides training to healthcare professionals to effectively use telemedicine solutions both on site and remotely through the use of telehealth equipment with the help of training specialists. This training will be helpful in implementation of electronic medical records, training and support for a telemedicine system, and doing technical assessments and business analyses.40

e-Governance in Health Sector Under e-Governance Network Statewide
The Department of Information Technology, GoI has launched the National e-Governance Action Plan with the intent to support the growth of e-governance within the country. A separate “e-Governance Standards Division” has been created by the NIC to steer the process of evolving the standards.

COMMON SERVICE CENTER (100,000 NODES), DIT PROJECT
DIT has formulated a proposal to establish 100,000 Common Service Centers (CSCs) in 600,000 villages of India, which will connect the citizens of rural India to the World Wide Web. CSCs would extend the reach of electronic services, both government and private, to the village level. Various government departments have been advised to design and evolve their Mission Mode Projects, laying adequate emphasis on services and service levels in respect of their interface with citizens and businesses. Telemedicine has been identified as one of the service modules.

VILLAGE RESOURCE CENTER (VRC)
The VRC concept has been evolved by ISRO to provide a variety of services such as tele-education, telemedicine, online decision support, e-governance services, weather services, and water management.41 It will provide connectivity to specialty hospitals, thus bringing the services of expert doctors closer to the villages. As of now, 445 VRC nodes have been established in many states across the country.

Policy Initiatives
STANDARDIZATION OF TELEMEDICINE PLATFORM AND SERVICES
DIT has taken a crucial role in defining and shaping the future of telemedicine application in India. To standardize services of different telemedicine centers, a document entitled “Recommended Guidelines & Standards for Practice of Telemedicine in India” has been prepared by the DIT that is aimed at enhancing interoperability among various telemedicine systems being set up in the country. These standards will assist the DIT and the state governments and healthcare providers in planning and implementation of operational telemedicine networks.1

Defining IT Infrastructure for Health
DIT also undertook initiative, in a project mode, for defining “The framework for Information Technology Infrastructure for Health (ITIH)” to efficiently address information needs of different stakeholders in the healthcare sector.1

National Task Force on Telemedicine
MOH&FW set up a National Task Force on Telemedicine in 2005 that is addressing various issues in telemedicine in the national con-
text. Various subcommittees are working on these issues to develop a national policy document. Terms of references of the task force were defined to work on interoperability, standards, a national telemedicine grid, to identify all players and projects and evaluate them, to prepare pilot projects and a national cancer telemedicine network, and to draft a national policy on “telemedicine and telemedical education.”

**e-Health Industry**

The prominent Indian industries providing hardware and software supports are C-DAC, Pune, Mohali & Thiruvananthapuram; Apollo Telemedicine Network Foundation, Hyderabad; Online Telemedicine Research Institute, Ahmedabad; Televital India, Bangalore; Vepro India, Chennai; Prognosys Medical Systems Pvt. Ltd., Bangalore; Medisoft Telemedicine Pvt. Ltd., Ahmedabad; idiasign Technology, Ahmedabad; Karishma Software Ltd., New Delhi; Neurosynaptic Communications Pvt Ltd., Karnataka; Amrita Technologies, Kerala; Larsen & Turbo, Mumbai; West Bengal Electronics Industry Development Corporation Ltd., Kolkata; and Space Hospitals Ltd., Chennai.42

**Research and Development**

**DIT INITIATIVE**

DIT, along with its societies such as Center for Development of Advanced Computing (CDAC),43 Media Lab Asia,44 and in collaboration with many premier medical and technical institutions such as SGPGIMS, AIIMS, PGIMER, and Indian Institute of Technology, is involved in research, design, development, and deployment of advanced telemedicine products and solutions. They also specialize in embedded and VLSI technology, biomedical, electronics, telemedicine, and entrepreneurship development. It has also developed the institution-based, application-oriented telemedicine software systems “Mercury” and “Sanjeevani” and validated them at three premier medical institutions of the country.

**SGPGIMS INITIATIVE**

In collaboration with its technical partners, SGPGIMS developed and validated several application modules in telemedicine besides development of prototypes Tele-ambulance for emergency healthcare, Mobile Tele-hospital for rural healthcare, and portable suitcase telemedicine module for disaster situations.

**Research Publications**

India has contributed numerous research publications in peer-reviewed scientific journals and book chapters in related fields. A compendium of these publications can be found at the Telemedicine India Web portal.42

**National Scientific Societies**

The Telemedicine Society of India,45 The Medical Computer Society of India,46 and The Indian Medical Association of Informatics47 are actively involved in organization of annual scientific meetings to develop awareness and providing a platform for sharing research experience in this emerging field of healthcare informatics.

**Future Perspective of Telemedicine in India**

The Government of India is planning and implementing various national level telemedicine projects and deploying mobile and fixed telecenters within the country to provide healthcare facilities to the remotest and poorly accessible areas of the country. ISRO telemedicine nodes are expanding and are also planning to launch a dedicated satellite, HEALTHSAT, for healthcare delivery. Encouraged by the success of the Kerala ONCONET project, MoHFW is planning to implement the “OncoNET” India project, which will network 27 Regional Cancer Centers with 100 Peripheral Cancer Centers to facilitate National Cancer Control Program. NRTN48 is another major initiative coming up under National Rural Health Mission. A major national initiative—the National Medical College Network Project is coming up in the field of e-learning—to establish a national telemedicine grid for networking all the medical colleges to implement the recommendation of the National Knowledge Commission. Few tertiary care academic medical institutes from different regions of the country will be identified as Medical Knowledge Resource Centers (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 have overall responsibility to coordinate the National

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*Fig. 2. School of Telemedicine and Biomedical Informatics, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India.*
Network in addition to providing infrastructure for the Central Content Development Center. Under DIT support, the National Resource Center for Telemedicine & Biomedical Informatics has been established at the School of Telemedicine and Biomedical Informatics, SGPGIMS, Lucknow (Fig. 2). The Department of Information Technology is planning to launch various other projects in collaboration with government organizations: 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. The 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, is planning to develop the Indian Health Information Network. In the international collaboration area, DIT is also collaborating with the European Union (EU) in various fields including e-governance and e-health. Bridging Europe’s Electronics Infrastructure to Expanding Frontiers–Education and Research Network, India’s project proposal, e-health. Bridging Europe’s Electronics Infrastructure to Expanding the European Union (EU) in various fields including e-governance and

Conclusions
Telemedicine technology can bring revolution to the field of medicine. Using a number of high-speed satellite and terrestrial telecommunications links, centralization and coordination of resources, and support of government, it has been possible to reach and access the Indian population spread out in heterogeneous geography and thus achieve the goal of health for all. India has taken a lead in this field among the developing countries. However, all the activities need to be evaluated in a national framework, and many issues, such as national e-health policy, and legal/ethical issues need to be addressed.

Disclosure Statement
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