Accessing Specialist Services via Telemedicine in India

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Abbreviations

AIIMS	All India Institute of Medical Sciences
AIMS	Amrita Institute of Medical Sciences
AHF	Asia Heart Foundation
C-DAC	Centre for Development of Advanced Computing
CHC	Community Health Centre
CME	Continuing Medical Education
CollabDDS	Collaborative Digital Diagnosis System
CSC	Common Service Centre
CTI	Computer Telephone Integrated
DH	District Hospital
DIT	Department of Information Technology
DoS	Department of Space
ECG	Electrocardiogram
ICT	Information and Communication Technology
ICMR	Indian Council of Medical Research
ISRO	Indian Space Research Organisation
MC	Medical Centre
MCI	Medical Council of India
MoHFW	Ministry of Health and Family Welfare
NCD	Non-communicable disease
NHM	National Health Mission
NKN	National Knowledge Network
NTN	National Telemedicine Network
PGIMER	Post Graduate Institute of Medical Education & Research
PHC	Primary Health Centre
PIP	Programme Implementation Plan
PTC	Primary Telemedicine Centre
SATCOM	Satellite Communication
SDH	Sub District Hospital
SGPGIMS	Sanjay Gandhi Postgraduate Institute of Medical Sciences
SGRH	Sir Ganga Ram Hospital
STC	Secondary Telemedicine Centre
TCIL	Telecommunications Consultants India Limited
TCC	Telemedicine Consulting Centre
TM	Telemedicine
TSC	Telemedicine Specialty Centre
TSI	Telemedicine society of India
TTC	Tertiary Telemedicine Centre
UT	Union Territory
VRC	Village Resource Centre
WHO	World Health Organization

Abstract

India is a huge country with a population of diverse social and cultural backgrounds. The majority of its population lives in rural areas. The burden of disease continues to be high in the country with life expectancy at around 68 years, much lower compared to countries in the East Asian region and other advanced economies. As per International Standards, MMR at 130 per 100,000 live births and IMR at 37 per 1,000 live births are high.

The public healthcare system in rural areas in India is not only inadequate in terms of population coverage, but is also underutilized due to poor quality of healthcare services. Further, chronic absenteeism of healthcare staff and grossly lacking availability of specialists makes the situation worse. Majority of the population of specialists/doctors live in cities and small towns. Telemedicine can be an ideal solution in such situations. Telemedicine make use of telecommunication technologies which can enable patients in rural areas to get consulted and spoken to by specialists remotely. It can act as a tool to bridge the wide gap in the access to quality healthcare specialsist services between the rural and urban areas.

In India, Indian Space Research Organisation (ISRO) is the pioneer in the field of telemedicine. The other key players are the Department of Information Technology (DIT) under Ministry of Communications and Information Technology, Ministry of Health and Family Welfare, Ministry of External Affairs and the state governments. Some of the premier medical institutions and corporate hospitals are also actively involved in the telemedicine activities in India.

The present paper gives a detailed account of the telemedicine technology, its importance and various areas of application. The telemedicine initiatives in Indian context are presented in detail. Further, research and development in the field of telemedicine in India is discussed. A brief account of key challenges related to implementation of telemedicine in India are also highlighted.

Keywords: Telemedicine, ICT, Information and Communication Technology, India

Introduction

India is a large country with a population of more than 1.3 billion[1]. Around 68.84% of its population live in rural areas where most of the healthcare facilities are still not available or accessible(Chellaiyan, Nirupama, and Taneja 2019). Around 75% of the population of doctors resides in cities and towns making it difficult for rural and remote population to have access to quality healthcare(Chellaiyan, Nirupama, and Taneja 2019). Bajpai et al. in their paper titled "Increasing the availability of specialist services in rural India" explored the potential solutions to improve the availability of specialist services in rural India(Bajpai, Dholakia, and Vynatheya 2013). They suggested the use of Information and Communication Technology, particularly the telemedicine and video-conferencing, can be an innovative strategy for improving doctor patient interaction and should be explored further. Bajpai et al. in their paper titled "Intersectoral convergence and ICTs: Integrated ICT Approached to rural poverty development" examines the role telemedicine can play in the delivery of healthcare services in the rural and remote regions which are isolated from the mainstream(Bajpai et al. 2019). Bagchi Sanjit also explored the role of telemedicine in rural India(Bagchi 2006). He concluded his paper very well with Dr. Devi Shetty words:

"In terms of disease management, there is [a] 99% possibility that the person who is unwell does not require [an] operation. If you don't operate you don't need to touch the patient. And if you don't need to touch the patient, you don't need to be there. You can be anywhere, since the decision on healthcare management is based on history and interpretation of images and chemistry … so technically speaking, 99% of health-care problems can be managed by the doctors staying at a remote place—linked by telemedicine"(Bagchi 2006).

"Tele" in Greek means "distance" and "mederi" in Latin means "to heal"(Dasgupta and Deb 2008). As per World Health Organization (WHO), Telemedicine is defined as, "The delivery of healthcare services, where distance is a critical factor, by all healthcare 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 healthcare providers, all in the interests of advancing the health of individuals and their communities(World Health Organization 2010)." Telemedicine includes both "the clinical (diagnosis, treatment and medical records) and academic medicine (research, education and training)"(Singh 2006).

Why Telemedicine?

- To overcome the shortage of medical specialists in rural and remote areas
- To reduce the increasing expenditure related to patient referrals
- To achieve uniformity in providing quality care to all the patients
- To provide Continuing Medical Education (CME)
- To provide care to home-bound and non-ambulatory patients
- To act as a public awareness tool

[1] https://en.wikipedia.org/wiki/Demographics_of_India

- To facilitate provision of services to remote areas in case of natural calamities, military and space operations
- To act as a disease surveillance tool
- To act as a tool for remote monitoring of healthcare practices, education and training
- Increase in revenue and patient load
- Helps improve follow up care and health outcomes

Telemedicine System

The Telemedicine unit at the patient end is composed of four modules: **the bio-signal acquisition module** for capturing patient's bio-signals like heart rate, ECG, Temperature etc., **a digital camera** for capturing images, **a processing unit** usually a computer and **a communication channel** (GSM, satellite, POTS modem, Internet, WAN, PAN, etc.)(Ajami and Lamoochi 2014). The Telemedicine system at the doctor's end is composed of hardware (computer, printer, scanner, videoconferencing equipment etc.), software (which enables the acquisition of patient information in the form of images, reports, films etc.) and a communication channel (GSM, satellite, POTS modem, Internet, WAN, PAN, etc.) whereby two locations can connect to each other(Ajami and Lamoochi 2014). Telemedicine Consulting Centre (TCC) is the location/site where the patient is present for seeking health care service(Dasgupta and Deb 2008). Telemedicine Specialty Centre (TSC) is a location/site, where the specialist is present for consultation(Dasgupta and Deb 2008).

Telemedicine Delivery Methods

Telemedicine delivery methods can be classified into two categories: One according to the timing of information transmitted and the other as per the type of interaction between individuals(Chellaiyan, Nirupama, and Taneja 2019). See Table 1 for details.

Table 1 : Telemedicine Delivery Methods

1. According to the timing of information transmitted
1.1 Real time telemedicine (synchronous) or Two way interactive television (IATV) Telemedicine
➢ "Face to face" consultation between two persons at two different locations ➢ Both the sender and the receiver are available online at the same time and there is a transfer of "live" information ➢ For instance, between the specialist at the Telemedicine Specialty Centre (TSC) and the patient at the Telemedicine Consulting Centre (TCC) ➢ Commonest type of delivery method ➢ Used in all specialities of medicine including cardiology, obstetrics and gynaecology, neurology, psychiatry, paediatrics, internal medicine and rehabilitation
1.2 Store and Forward or asynchronous Telemedicine
➢ Digital images are captured using a digital camera, stored and then forwarded using a computer from one location to another ➢ The sender can send and receiver can review the information as per their own convenience ➢ Used in Teleradiology, Telepathology and Teledermatology

1.3 Remote Monitoring Telemedicine
➢ This is done for the purposes of monitoring the clinical condition of the patient from a distance(remotely)
2. According to the type of interaction between individuals
2.1 Health professional to Health professional
➢ This is done for the purposes of consultation, expert care, training and education
2.2 Health professional to Patient
➢ This is done to provide healthcare service to the needy people in the rural and remote areas

Telemedicine Centre

Telemedicine centres are classified into three classes(Dasgupta and Deb 2008). These are:

- Primary Telemedicine Centre (PTC) based in Primary Health Centres (PHCs)
- Secondary Telemedicine Centre (STC) based in Secondary Medical Centres
- Tertiary Telemedicine Centre (TTC) based in Tertiary Medical Centres

Applications of Telemedicine

Table 2 outlines the various applications of Telemedicine(Chellaiyan, Nirupama, and Taneja 2019; Dasgupta and Deb 2008).

Table 2: Applications of Telemedicine

Healthcare Delivery and Management	
Tele-Health care	This incorporates use of ICTs for the purpose of health care delivery. It includes both Tele-consultation and Tele-follow up. Tele-consultation is useful to have a quick access to a medical specialist remotely.
Tele-Home Health Care	This is remote patient monitoring for 24 hours using a system called Computer Telephone Integrated (CTI) from a central location.
Health Care Specialities	This includes Tele-ophthalmology, Tele-psychiatry, Tele-cardiology and Tele-surgery.
Diagnostic Services	This includes Tele-radiology and Tele-endoscopy.
School-Based Health Care	Telemedicine can help link schools with a specialist for medical advice in emergency cases.
Correctional Facilities	Telemedicine can help link correctional facilities with the specialist for medical advice related to inmates care. This is helpful in avoiding the risk involved in transporting inmates to the health care facility.
Shipping Industry	Telemedicine can help link ships to the medical specialist in a healthcare facility in case of an emergency. This can help avoid any unnecessary route diversions for seeking immediate medical care.
Educational	
Tele-education	This includes long distance training and education related to the advances in the treatment methodology.
Tele-Conferencing	This is virtual interaction and discussion between doctors during the conferences, workshops, Continuing Medical Education (CME) etc.

Tele-Procutoring	This includes distance evaluation and mentoring of surgical trainees.
Screening of Diseases	
Diabetes Screening	The Chunampet Rural Diabetes Prevention Project by MDRF
Ophthalmology screening	Ophthalmology screening by Aravind Hospitals at Andipatti Village in the state of Tamil Nadu, India
Disaster Management	
Telemedicine Services during Disaster	Telemedicine services by Amrita Hospital in Kochi, India during 2004 Indian Ocean Tsunami
Public Health	
Epidemiological surveillance	This include real time monitoring of diseases, anticipating epidemics etc.
Health Promotion and Disease prevention	This includes informing individuals and population on risky behaviours and counselling on adoption of healthy life style.

Telemedicine Initiatives in India

Indian Space Research Organisation (ISRO), the Department of Information Technology (DIT), Ministry of Communications and Information Technology, Ministry of Health and Family Welfare, Ministry of External Affairs and the state governments of India are the key players in establishing telemedicine network all over the country (Chellaiyan, Nirupama, and Taneja 2019).

Early Initiatives

It began in the year 1999 when Indian Space Research Organisation (ISRO) started establishing SATCOM based telemedicine networks across the country(Saroj Kanta Mishra, Kapoor, and Singh 2009). As per the report presented in the Rajya Sabha in the year 2002, several telemedicine projects were implemented in the country(Bagchi 2006). This included the Andaman Nicobar Islands telemedicine project interlinking Sri Ramachandra Medical College and Research Institute in Chennai with the G.B Pant Hospital in Port Blair, while District hospital in Chamarajnagar and Vivekananda Memorial Hospital, Saragur were connected to Karnataka Narayana Hrudayalaya (Bagchi 2006). Among these early telemedicine initiatives, there are also reports of telesurgery procedure performed in the year 2003 on Jan 13th at Pampa, as reported by The Amrita Telemedicine Programme(Bagchi 2006). The remote guidance by the cardiothoracic surgeon to the paediatric cardiologist at the Amrita Emergency Care Unit at Pampa helped save the life of a pilgrim. After the 2004 tsunami, mobile telemedicine units were made available in the coastal areas and islands of India for emergency medical consultations(Bagchi 2006).

Policy Initiatives

Standardization of Telemedicine practice

The Department of Information Technology, Government of India has set up standardized telemedicine practice guidelines entitled “Recommended Guidelines & Standards for Practice of Telemedicine in India” in the year 2003[2](Bedi and NMurthy 2003; Saroj Kanta Mishra, Kapoor,

[2] http://v2020eresource.org/content/files/guidelinessandstandards.pdf

and Singh 2009). It is aimed to improve the interoperability between various telemedicine systems being established across the country.

National Task Force on Telemedicine

The Ministry of Health, Government of India, has set up National Telemedicine Task Force, in September 2005 under the chairmanship of the Secretary, Union Ministry of Health and Family Welfare (Telemedindia 2011b). It comprises of members from Union ministries (Health, Space, and Communication & Information Technology); technical agencies (ICMR, ISRO, C-DAC, MCI); corporate hospitals, and academic medical institutions involved actively in the practice of Telemedicine. It is aimed to address various issues related to Telemedicine at National level. Terms of References (TORs) of the National Task Force are given in Appendix 2.

National Steering Committee on Telemedicine

The National Steering Committee on Telemedicine was constituted in the year 2005(Dhamija 2013)[3].

Initiatives by Indian Space Research Organisation

Indian Space Research Organisation (ISRO) is the pioneer in the field of telemedicine in India. A nationwide telemedicine (TM) programme was initiated by Indian Space Research Organisation (ISRO) through its Department of Space (DoS) in the year 2001(Chellaiyan, Nirupama, and Taneja 2019). One of the early initiatives linked Apollo Hospital in Chennai with the Apollo Rural Hospital in Aragonda village in Chittoor district of Andhra Pradesh(Chellaiyan, Nirupama, and Taneja 2019). As per ISRO Annual Report 2004-2005, geo-stationary satellites helped link 78 remote/rural hospitals with the 22 super speciality hospitals in the country(Bagchi 2006). In the year 2009, Mishra et al. reported 315 hospitals: 271 rural/remote hospitals/health centres linked to 44 super speciality hospitals under the ISRO's satellite based telemedicine network.

ISRO's nationwide telemedicine programme has provided telemedicine systems including hardware, software, communication equipment as well as satellite bandwidth for 384 Hospitals in the country including 60 specialty hospitals; connected to 306 rural or remote/ district/medical college hospitals(Saroj Kanta Mishra, Kapoor, and Singh 2009; MInistry of Health and Family Welfare, Government of India 2018). This has enabled healthcare access to patients in remote places like Andaman and Nicobar Islands, Jammu and Kashmir, the Lakshadweep Islands and the tribal areas in the north-east and central regions of the country. Also, this initiative helped enable Satellite connectivity to Eighteen Mobile Telemedicine units in the country. Further, ten mobile tele-ophthalmology units were also reported to be established as a part of this network(Saroj Kanta Mishra, Kapoor, and Singh 2009). In recent years, ISRO'S telemedicine network has been expanded to link 15 super speciality hospitals with 45 rural and remote hospitals(Chellaiyan, Nirupama, and Taneja 2019).

[3] http://www.searo.who.int/entity/health_situation_trends/events/19_India_Country_Experience.pdf

Initiatives by the Department of Information Technology (DIT)

The Department of Information and Technology, Ministry of Communications and Information Technology, India has implemented various pilot projects in different states in India. These include the telemedicine network for the diagnosis and monitoring of tropical diseases in the state of West Bengal, the oncology network in the states of Tamil Nadu and Kerala, the network for speciality healthcare access in the hilly regions of Himachal Pradesh, the north-eastern states and in rural areas of Punjab(Saroj Kanta Mishra, Kapoor, and Singh 2009). The Department of Information and Technology helped link three premier Institutes in India: SGPGIMS in Lucknow, AIMS in New Delhi and PGIMER in Chandigarh and in turn facilitated linking them to the other state level hospitals(Saroj Kanta Mishra, Kapoor, and Singh 2009).

Global Telemedicine Initiatives by India

The Ministry of External Affairs, India have also taken a few initiatives like Pan-African Network Project and the SAARC Telemedicine Network projects(Saroj Kanta Mishra, Kapoor, and Singh 2009). This has helped placing telemedicine initiatives in India in the global context. Under the SAARC telemedicine network, one or two hospitals in each of the SAARC countries have been connected with the super speciality hospitals in India: AIMS in New Delhi, SGPGIMS in Lucknow, PGIMER in Chandigarh and CARE Hospital in Hyderabad[4]. Further, Jigme Dorje Wangchuck National Referral Hospital in Thimpu, Bhutan has been connected with SGPGIMS, Lucknow and PGIMER, Chandigarh[7]. The Pan-Africa e-Network is an ICT project between India and Africa[5]. The project aimed to connect 55 member states of the African Union via a satellite and fibre-optic network to India and to each other to facilitate sharing of expertise in the areas of telemedicine, Tele-education, e-governance etc. between India and African states. This initiative by the Ministry of External Affairs was implemented through the Telecommunications Consultants India, Ltd (TCIL).

Initiatives by Ministry of Health and Family Welfare (MoHFW)

National Telemedicine Network

A National Telemedicine Network (NTN) has been envisaged by the MoHFW, Government of India to provide telemedicine Services to the remote and rural areas across the country(Ministry of Health & Family Welfare 2018; MInistry of Health and Family Welfare, Government of India 2018; 2016). Under this initiative, existing Government Healthcare Facilities (MC, DH, SDH, PHC, and CHC) in all the States/UTs will be upgraded to provide these services. Telemedicine nodes will be established across India inter connecting these healthcare facilities.

State Telemedicine Network

Under the Programme Implementation Plan (PIP) of National Health Mission (NHM), States/UTs are being supported for the development of Telemedicine system(MInistry of Health and Family Welfare, Government of India 2016). As per MoHFW annual report 2017-2018, ten states have

[4] https://pdfs.semanticscholar.org/1503/f3ca6457d6e8e566b514d600c08a02b170c5.pdf
[5] https://en.wikipedia.org/wiki/Pan-African_e-Network_project

been financially supported to strengthen telemedicine system under the State Telemedicine Network(Ministry of Health & Family Welfare 2018).

Establishment of SATCOM based Telemedicine nodes at Pilgrim Places

The Union Health Ministry has envisaged satellite based telemedicine nodes at the places of pilgrimage in the country(Ministry of Health & Family Welfare 2018; MInistry of Health and Family Welfare, Government of India 2016). In collaboration with Department of Space, Space Technology Tools will be utilized for providing the tele-medicine facility between identified remote health facility and the specialty hospital. As per the proposed plan, the remote health facility will be linked to the specialty hospital in their respective states. But, the tele-consultation can be done with any of the super-specialty nodes established across the country. This will make treatment accessible to both the sick pilgrims as well as the local inhabitants. The focus will be on the speciality consultation, health awareness and the screening of non-communicable disease (NCD). As per MoHFW annual report 2017-2018, there are four active sites. These are "Kashi Vishwanath Temple, Varanasi, Uttar Pradesh; Maa Vindhyavasini Mandir, Vindhyachal Dham, Mirzapur (UP); Sheshnag, Amarnath Pilgrimage (J&K); and Pampa Hospital, Ayyappa Temple at Sabrimala in Kerala"[6](Ministry of Health & Family Welfare 2018).

National Medical College Network

The National Medical College network is an initiative which intends to interlink all the medical colleges across the country using the National Knowledge Network (NKN) as the backbone(Ministry of Health & Family Welfare 2018; MInistry of Health and Family Welfare, Government of India 2018; 2016). The purpose of the scheme is to provide Tele-education and Tele-consultation. Fifty Govt. Medical Colleges are being interlinked under this project. Super-speciality doctors in these medical colleges will share their experiences and knowledge through virtual classroom (e-learning) and will also provide medical consultation virtually to the patients at home, at government health centres, and at Common Service Centres in rural/remote areas via a web portal. Under the Phase-I, One National–cum-Regional Resource Centre, 42 other medical colleges and 7 regional resource centres will be networked utilising connectivity provided by National Knowledge Network (NKN). Other National Telemedicine projects include National Cancer Network and National-Tele-Ophthalmology Network (Dhamija 2013).

State-Level Telemedicine Initiatives

The state governments are also a key player in the development of Indian Telemedicine. Some of the state level telemedicine initiatives are mammography services at Sri Ganga Ram Hospital in New Delhi, Oncology services at Regional Cancer Centre in Trivandrum, surgical services at the School of Telemedicine and Biomedical Informatics, Sanjay Gandhi Postgraduate Institute of Medical Sciences, telemedicine practice by Government of Uttar Pradesh during Maha Khumbhmelas etc. Table 3 give details about the telemedicine nodes and their linkage to speciality hospital established in various states in India (Saroj Kanta Mishra, Kapoor, and Singh 2009).

[6] https://mohfw.gov.in/sites/default/files/20Chapter.pdf

Table 3 : Telemedicine network established in various states in India

State	Number of Telemedicine Nodes	Speciality Hospital
Jammu and Kashmir	12 District Hospitals	Sher-e-Kashmir Institute of Medical Sciences Hospital, Srinagar
Himachal Pradesh	19 Health Centres at District, Block and Tehsil headquarters	IGMC Shimla and PGIMER Chandigarh
Punjab	20 District Hospitals	Government Medical College and Hospital and five polyclinics of the state
Uttarakhand	2 District Hospitals	SGPGIMS, Lucknow
North Eastern States	District Hospitals each of seven North eastern states	Narayana Hrudayalaya, Bangalore
Jharkhand	22 District Hospitals	3 Medical Colleges and Hospitals
West Bengal	12 District Hospitals	School of Tropical Medicine, NRS Medical College &Hospital, Kolkata, Burdwan Medical College & Hospital, Burdwan
Rajasthan	32 District Hospitals	6 State Medical Colleges
Chhattisgarh	Two at Medical Colleges	Government Medical Colleges at Raipur &Bilaspur that further link to premier hospitals of the country
Orissa	5 District Hospitals	3 Medical Colleges that further linked with SGPGIMS
Karnataka	26 District Hospitals	Narayana Hrudayalaya, Bangalore
Tamil Nadu	6 District Hospitals	Government General Hospital, Royapettah Hospital, Adiyar Cancer Center11-all at Chennai
Kerala	14 District Hospitals and two taluk Hospitals	AIIMS, New Delhi, Amrita Institute of Medical Sciences(AIMS),Kochi, and Sri Chithira Tirunal Institute of Medical Science and Technology, Thiruvananthapuram

Academic Institution Initiatives

The SGPGIMS in Lucknow, AIIMS in New Delhi and PGIMER in Chandigarh are the premier Institutions involved in establishing the telemedicine networks throughout the country(Saroj Kanta Mishra, Kapoor, and Singh 2009). Other Institutions which are playing an active role include Sri Ramachandra Medical College in Chennai, Tata Memorial Hospital in Mumbai and Christian Medical College, Vellore(Saroj Kanta Mishra, Kapoor, and Singh 2009).

Private Sector Initiatives

Private sector has also played a crucial role in the development of telemedicine services in India. 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 Hrudayalaya, Bangalore (linked with 55 nodes) and Escorts Heart Institute and Research Centre (linked with 17 nodes). Sir Ganga Ram Hospital (SGRH), New Delhi has launched its telemedicine centres in Haryana and Rajasthan states"(Saroj Kanta Mishra, Kapoor, and Singh 2009).

Mobile Telemedicine

With rapid advances in mobile technology, Mobile Telemedicine, an improved version of telemedicine holds promise for the delivery of medical care to the rural population in India. Table 1 outlines a few of the mobile telemedicine initiatives taken in India.

Table 4 : Mobile Telemedicine Initiatives in India

S.No	Mobile telemedicine Initiatives in India
1.	Mobile Telemedicine Bus service by SGPGI (NRC), Lucknow and AIMS Cochin(S.K Mishra 2018)
2.	"Lifeline Express", world's first Wi-Fi enabled hospital on train, an initiative by Impact India Foundation and Indian Railways(S.K Mishra 2018)
3.	Portable mobile telemedicine Kiosk launched by mhealth4u (S.K Mishra 2018)
4.	Yolo ATM and Kiosk launched by Yolo health(S.K Mishra 2018)
5.	The patent (pending) AmbuPod, mobile telemedicine clinic and ambulance by LYNK AmbuPod Pvt Ltd (Sridhar 2017; S.K Mishra 2018)
6.	Asha Jyoti Mobile Women's Healthcare service launched in the year 2012, an initiative by RAD-AID in collaboration with Philips Healthcare and implemented by PGIMER Chandigarh and Clinton Foundation(S.K Mishra 2018)
7.	Telemedicine through "104 service" launched by the state of Andhra Pradesh(Saroj Kanta Mishra, Kapoor, and Singh 2009)
8.	Mobile telehospital service launched by SGRH, AIMS, SRMC and AHF for providing speciality care to rural areas(Saroj Kanta Mishra, Kapoor, and Singh 2009)
9.	Mobile tele-ophthalmology service by Shankar Nethralya in Chennai, Aravinda Eye Hospital, Meenakshi Eye Mission at Madurai and four more corporate hospitals for the treatment of ophthalmic ailments under the National Blindness Control Program(Saroj Kanta Mishra, Kapoor, and Singh 2009)
10.	BPL Mobile, Maharashtra has launched a value-added service for its subscribers via which real time interaction and assistance with doctors is possible at any time and any place(Saroj Kanta Mishra, Kapoor, and Singh 2009)
11.	AROGYASREE, a mobile telemedicine initiative by ICMR in collaboration with the University of Karlsruhe, Germany(Chellaiyan, Nirupama, and Taneja 2019)

Other Initiatives

Some of the other telemedicine initiatives in India are

- Sky Health Centres, an initiative by World Health Partners and Melinda Gates Foundation(S.K Mishra 2018)

- Collaborative Digital Diagnosis System (CollabDDS), developed by National Informatics Centre, Government of India, helps visualise medical and dental images for the purpose of diagnosis and treatment planning(Ministry of Electronics and Information Technology and Government of India 2019).
- Village Resource Centre (VRC) is an initiative by ISRO for various Tele services including Telemedicine and Tele-education. So, far 500 VRCs have been set up in the country(Chellaiyan, Nirupama, and Taneja 2019).
- Common Service Centres (CSCs), an initiative by DIT, which will connect rural areas in India to the mainstream through a number of services including telemedicine(Saroj Kanta Mishra, Kapoor, and Singh 2009)
- e-medicine scheme for rural areas is proposed by the state government of Gujarat(Saroj Kanta Mishra, Kapoor, and Singh 2009).

Research and Development Related to Telemedicine

Initiatives by DIT

The Department of Information and Technology, Ministry of Communications and Information Technology, India in collaboration with the Centre for Development of Advanced Computing (C-DAC), Media Asia Lab and other premier institutes in India has undertaken various telemedicine related research and development initiatives(Saroj Kanta Mishra, Kapoor, and Singh 2009). They are involved in the entire cycle of research, design, development and deployment of various telemedicine products and related services. These include telemedicine solutions like "MercuryTM We Telemedicine Central (MWT-C)", "eSanjeevani" and "e-Dhanwanthari"(Saroj Kanta Mishra, Kapoor, and Singh 2009; Centre for Development of Advanced Computing (C-DAC) 2019). These telemedicine systems are operational in various centres in the states of Kerala, Punjab, Himachal Pradesh, Tamil Nadu and Odisha. Mobile telemedicine systems like Mobile Tele-Ophthalmology System and Mobile Tele-Oncology System were also developed by C-DAC(Saroj Kanta Mishra, Kapoor, and Singh 2009; Centre for Development of Advanced Computing (C-DAC) 2019).

Initiative by SGPGIMS

SGPGIMS in collaboration with technical partners has been involved in the development and validation of various telemedicine applications. These include Tele-ambulance for healthcare in emergency situations, mobile Tele-hospital for healthcare in rural areas and portable suitcase telemedicine module for situations like disaster and other natural calamities(Saroj Kanta Mishra, Kapoor, and Singh 2009).

National Telemedicine Society

The Telemedicine society of India (TSI) is an independent scientific body founded in the year 2001 during a National Telemedicine Conference held in the state of Lucknow in India(Telemedicine Society of India 2017). The TSI is dedicated to promote awareness related to telemedicine at

national level and is involved in the organization of scientific meetings on annual basis for the purpose of sharing research experiences in the field of telemedicine. The aims & objectives of the Telemedicine society of India (TSI) are given in the Annexure1.

Telemedicine India Web Portal

The telemedicine India Web portal is being designed and developed by SGPGIMS, Lucknow, India supported by Sony, Japan(Telemedindia 2011a). It will act as a knowledge base and a source of reference for all the documents, reports and research work related to the field of Telemedicine in India.

e- Support

Telemedicine related e-support including hardware and software support is provided by a number of industries in India. These include "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; idiagnosis Technologies, 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"(Saroj Kanta Mishra, Kapoor, and Singh 2009).

Capacity Building Initiatives related to Telemedicine

- The School of Telemedicine and Biomedical Informatics has been set up by SGPGIMS, Lucknow to conduct structured training and provide consultancy services related to Telemedicine in collaboration with various Indian and Foreign Universities(Saroj Kanta Mishra, Kapoor, and Singh 2009). The Department of Information and Technology, Ministry of Communications and Information Technology, India has identified the Department of School of Telemedicine and Biomedical Informatics as a National Resource Centre for Telemedicine(Saroj Kanta Mishra, Kapoor, and Singh 2009).
- In Collaboration with the Anna University in Chennai, the Apollo Telemedicine Network Foundation has initiated a Certificate Course in telehealth technology(Saroj Kanta Mishra, Kapoor, and Singh 2009).
- "Rad Gurukul", first ever teleradiology training centre in India, has been launched by "Teleradiology Solutions", a Bangalore based teleradiology service provider(Saroj Kanta Mishra, Kapoor, and Singh 2009).
- C-DAC Mohali conducts training for the healthcare professionals to use telemedicine equipment both on site and remotely(Saroj Kanta Mishra, Kapoor, and Singh 2009).

Key challenges

Undoubtedly, telemedicine has a potential to bring the specialist care closer to the needy people in rural areas of the country. However, the way leading to this revolutionary reform is filled with

challenges. In a country like India, where basic medical care is still not available in rural areas, establishment of technological infrastructure for the delivery of telemedicine is a challenging task. There are concerns related to technical problems like lack of interoperability standards for the telemedicine software, electricity availability, low bandwidth etc. The cost of implementation of telemedicine systems is also quite high. Further, patients are apprehensive about e-medicine and its outcome. There are concerns related to misdiagnosis and the related problems. The acceptance of the new technology is also an issue among the professionals. They worry that there could be mismanagement of the patient due to poor bandwidth or unavailability/inaccessibility to patient's previous records etc. The technology to deliver a good quality telemedicine service is still in the development stages. Further, the electronic transmission of patient data can be a target of hackers and thus raise concerns related to data security. There is no clarity related to legislation and medico-legal issues arising out of telemedicine(Ateriya et al. 2018). India being a large country with a population of more than a billion people and diverse cultural and social background makes it difficult to accept and implement this new technology called telemedicine. Moreover, Indian government is federal in nature where health is a state subject and so, adoption and implementation of any new health initiative throughout the country will be a challenge. Further, hard to reach and difficult geographical regions in the country makes it difficult to spread the technology across India. Hopefully, the challenges in the way of implementing telemedicine will be addressed and telemedicine technology will boom in a few years' time.

Conclusion

While we believe that telemedicine can do a great deal more in the field of making specialist services available especially in the rural community health centers, at the same time it is important to focus on the following broad issues if this initiative has to succeed on scale: 1) proper training of doctors and other healthcare professionals to deliver the telemedicine technology effectively, including vastly improved Internet services; 2) a much higher level of public-private partnerships related to telemedicine activities; 3) working towards standardizing and licensing the practice of telemedicine across the country; 4) developing policies and guidelines to integrate telemedicine with the existing health system; 5) specific laws related to telemedicine practice, including strict legislation for handling patient information through telemedicine; 6) an efficient management structure for monitoring quality standards of telemedicine practice in the country; and 7) efforts should be made to educate public about telemedicine and its related benefits.

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Annexure 1: Aims & Objectives of Telemedicine Society of India (TSI)

Aims & Objectives of Telemedicine Society of India (TSI)	
1.	To promote and encourage development, advancement and research in the science of telemedicine and it's associated fields.
2.	To encourage and promote application of telemedicine technology in clinical care, education and research in the health sector.
3.	Fostering networking and collaboration among interest groups in telemedicine technology and professionals from different streams of science, health care providers, policy makers, NGOs and industry.
4.	To promote training of students, health professional, research fellows and technicians in various aspects of telemedicine. Also, to co-ordinate with academic institutions and Medical Council of India, AICTE, DOEACC and regulating agencies in developing curriculum for telemedicine training courses and incorporating appropriate modules in the Medical, Dental and Paramedical training programmes.
5.	To arrange regular scientific meetings, symposia, seminars and workshops.
6.	Spearheading the development of appropriate clinical and industry policies and standards.
7.	Disseminating knowledge in telemedicine field by publishing brochures, periodicals, and journals. Creating an exclusive web site for the society and regularly updating it with telemedicine news.
8.	To work in close collaboration with scientific organizations and the industry in development and implementation of innovative products & services related to tele health. Organizing trade exhibitions during annual meetings of the society.

Source: Telemedicine Society of India. 2017. "Telemedicine Society of India: Constitution & By Laws." http://www.tsi.org.in/pdf/law.pdf.

Annexure 2: Terms of Reference (TORs) of the National Task Force

Terms of Reference (TORs) of the National Task Force	
1.	To work on inter-operability, standards for data transmission, software, hardware, training etc.
2.	To define a national telemedicine grid and consider its standards and operational aspects.
3.	To identify all players and projects currently involved in telemedicine in India and evaluate their performance, capacity and replicability.
4.	To prepare pilot projects for connection of super specialty hospitals/ medical colleges with district hospitals and/or Community Health Centers / Primary Health Centers especially keeping in mind to provide access to remote areas.
5.	To prepare national cancer telemedicine network.
6.	To enable telemedicine centers in teaching institutions to impart training to all government medical/ dental/nursing colleges in three years time.
7.	To prepare curriculum and projects for CMEs through telemedicine.
8.	To draft a national policy on "telemedicine and telemedical education" and to prepare a central scheme for the 11th Five Year Plan.
9.	To define standards and structures of electronic medical records and patient data base which could be accessed on a national telemedicine grid.

10.	To examine possibilities of utilization of stand alone centers of department of communication in rural areas.

Source: Telemedindia. 2011. "National Task Force." 2011. http://telemedindia.org/ntf.html.