A 3-Level Integrated Telemedicine Network for Improving Healthcare Access to Rural India

Rajdeep Tyagi and Sripriya S

Abstract—**In a country like India, with its huge population, diverse landmass and where there is a shortage of qualified health workers and specialists in rural areas, telemedicine is going to be the most optimal solution to deliver expert advice from a central part to remotest corners of the country. In addition, as Indians spend most of their out-of-pocket health expenses on travel and accommodation in order to receive specialty treatments, Telemedicine will turn out to be the cheap and fast, as well as bridge the rural–urban health divides. With its huge strides in the medical field and expertise in ICT, India holds a great promise to become a leader in the field of telemedicine. There have been various efforts by disparate entities like ISRO, C-DAC, DRDO, and Apollo Hospitals and so on, which now needs a uniform, coordinated efforts and a larger participation from other players in the field of medicine and ICT. This paper proposes a 3-Level Integrated Telemedicine Network Infrastructure which would pave the way for an integrated telemedicine network in India.**

Keywords-telemedicine; healthcare; rural India; ICT, Tripura

I. INTRODUCTION

With an area of about 3.2 million square kilometers endowed with varied landscapes like mountain regions, deserts, green plains, and hilly areas, providing minimum healthcare to rural areas where 68% of the population lives is one of the biggest challenges for India. It is known that 90% of the secondary and tertiary healthcare facilities are present in cities and towns making it expensive and logistically difficult for people to get access for quality healthcare [1]. A study notes that those living in remote places have to travel more than five kilometers to access an in-patient facility, 63 percent of the time [2]. Lack of willingness, financial incentives and career progression are the main drawbacks that do not attract qualified personnel towards rural health facilities. This is where technology can play a huge role to bring quality healthcare to all, through telemedicine and can make a big impact of many lives.

Telemedicine can be best understood in terms of the services provided and the mechanisms used to provide those services:

- Store and Forward (Asynchronous): Medical data can be transmitted to seek expert opinion where expert doctor need not to be present at the same time.
- Real Time (Synchronous): Live interaction between the patient and doctor using phone/video conferences.
- Remote Monitoring: Chronic diseases or specific conditions can be remotely monitored using technology devices

The main objectives of Telemedicine should be to cross the geographical barriers and provide healthcare facilities to rural and remote areas, so that it is beneficial for the population living in isolated communities. Besides, the advantages of telemedicine are:

- Eliminate distance barriers and improve access to quality healthcare.
- In emergency and critical care situations where a moving patient could be assessed in advance and prepared for right treatment saving crucial time.
- Facilitate patients and rural practitioners' to access specialist health services and support.
- Reduce the inconvenience and/or cost of patient transfers.
- Reduce unnecessary travel for health professionals.
- Upgrading the knowledge of rural practitioners through tele-education.
- Developing virtual communities that interacts and shares knowledge [3]

II. CURRENT SCENARIO

A. Telemedicine Initiatives in India

Although telemedicine is in nascent stage in India, a number of initiatives are underway by the Department of Information Technology (DIT), Government of India. In addition to major support and thrust provided by DIT through projects and systems, organizations like ISRO, reputed academic medical institutions like SGPGI, AIIMS, PGIMER, AIMS, SRMC and corporate hospitals like Asia

Heart Foundation, Apollo Hospitals, SGRH, Fortis, Max etc. have taken and continuing to take significant initiatives for installation of telemedicine systems at different parts of the country [4]. Appendix I, Table 1 lists the major telemedicine initiatives in India and Table 2 lists the telemedicine network implemented in various states of India, but they are not exhaustive.

B. Tripura Vision Centre

Tripura, one of the North-Eastern states of India, is characterized by its mountainous and tough terrains. Agriculture serve as the livelihood for most and over 64% of the population live in rural areas. The rate and the number of needless blindness cases have been growing in Tripura during the last several years. Reaching out medical care, especially specialist care such as Ophthalmology is one of the major challenges, in terms of both infrastructure and resource limitations. Experts knew, it could be prevented by conducting preliminary eye screening and in time treatments. However the screening centers were located in Agartala, the capital. Individuals, especially women and children found it difficult both physically and economically to travel such long distances, besides having to wait long hours for their turn.

The Government of Tripura setup Vision Centers (VC) in various locations throughout the state equipped with basic ophthalmic equipments and manned by a trained ophthalmic assistant. The Vision Centers were connected to the central hospital at Agartala, though a wireless network. An ophthalmologist sitting at the central hospital could attend to a remote patient in the Vision Center using a Communication Platform using Audio and Video. The sessions could be recorded for archive, training and audit purposes. This tele- ophthalmology platform now caters to a population of 3,432,000 spread over 40 administrative units in the State of Tripura and has reduced travel for primary eye screening by over 70%. Eye screening ratio for women has increased by over 50% due to easier access of screening services [5]. The solution continues to prove itself to be an ideal vehicle for distance consulting. This is one such example of a telemedicine being implemented in India.

Although there are a number of laudable efforts, the disparate initiatives by these various organizations call for an overarching architecture/ framework for an integrated telemedicine network in India.

III. PROPOSAL OF A 3-LEVEL INTEGRATED TELEMEDICINE NETWORK INFRASTRUCTURE

We propose a 3-Level Integrated Telemedicine Network Infrastructure architecture for the country covering 3 levels, namely, a Telemedicine studio(PHC) to an intermediate care center(District/Regional tele-consulting center), intermediate care center to Intensified care/Super-specialty

hospitals which would pave the way for an integrated telemedicine network in India.

A. Telemedicine Studio

These centers will act as hubs which can employ Community Health Officers who can complement a registered standard physician in the rural health centers and provide basic health care [6]. These Community Health Officers should be well-trained on the Telemedicinal equipments and be provided with efficient diagnosis tools to collect medical data. Algorithm based intelligence should be built in these telemedicinal systems to diagnose standard and chronic illness cases, which shall be screened and forwarded along with patients' data to consultants at the other end.

Community health officers who are trained intensively and graduated from rural colleges are easier to retain. These low cost healthcare personnel shall have manageable people ratio—roughly one health officer for every 500 to 1000 people. This ratio ensures that workers can manage patients, check compliance, and follow up over time.

The range of health services they can handle should be focused enough to be manageable and affordable yet broad enough to cover a range of essential needs. These will include first aid, basic preventive and diagnostic services, the distribution of materials (say, nutritional supplements or condoms), and essential curative care—as well as the monitoring and treatment of chronic conditions. If the services provided are too narrow, patients will ultimately disregard them. Best practices programs should be implemented and shall focus on supervision and performance management— using checklists and other simple tools to keep guidance fair and thorough.

The major duty of the community health officers would be:

1. Assess patients' symptoms systematically using clinical algorithms/protocols

2. Collaborate and create a treatment plan for patient (Recommendations, Follow ups, Educating and supporting actions)

3. Prioritize patient treatments in the order of urgency

4. Evaluate outcomes and perform quality control checks

B. Intermediate Care

Once the patient's condition is assessed by monitoring all the vital signs and preliminary tests are completed at the Telemedicine studio, an electronic health record is created and recorded for future references. If a patient cannot be assessed through standard procedures, the electronic record is forwarded for a consultant's opinion, which will be reviewed by an expert doctor. A low-bandwidth audio/video conferencing facility should be able to connect to physician

sitting in a remote place for interaction with the patient along with the community health officer. An electronic prescription shall be provided by the physician. This process will minimize the precious time and effort spent by the patients. In addition, a special group conference shall be conducted to address the issues faced by patients of a similar category by a group of tele-consultants.
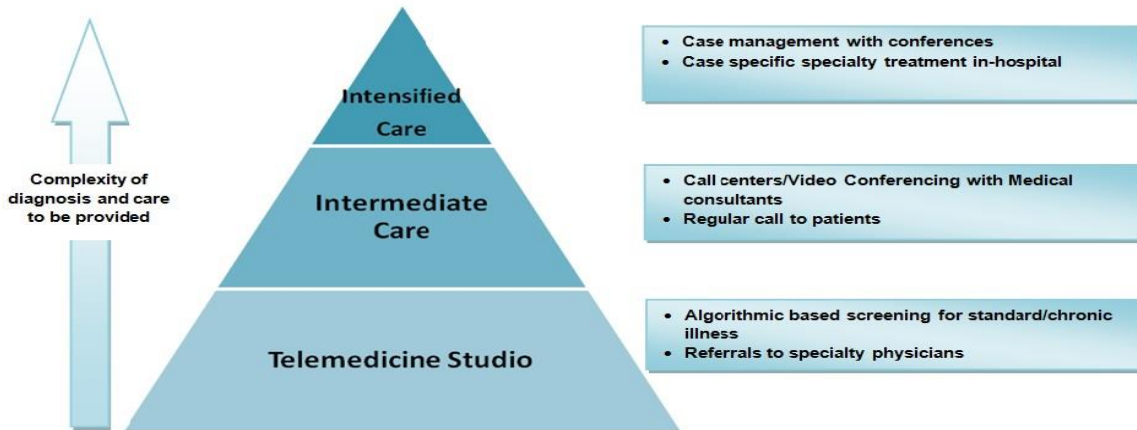
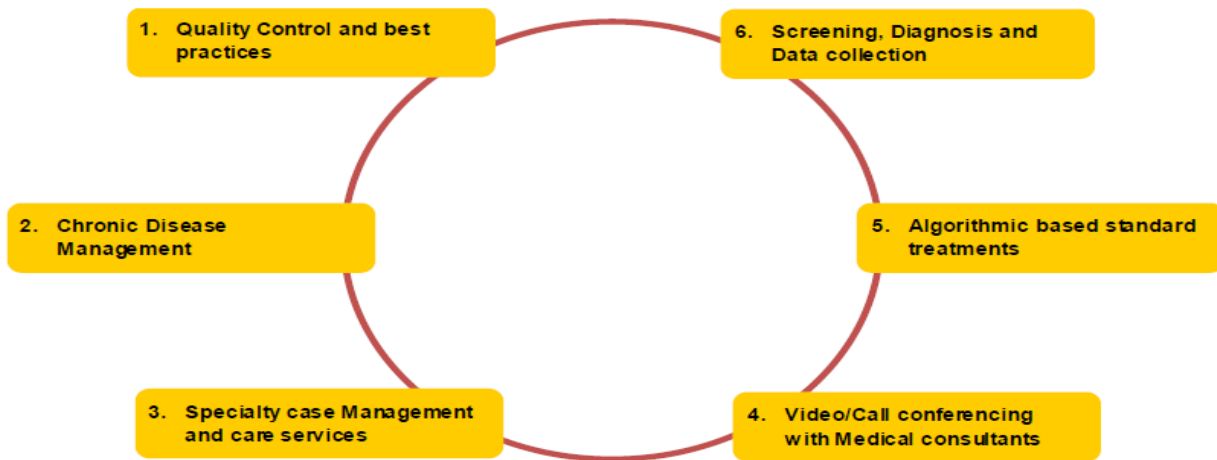Figure 1.   A 3-level Telemedicine Health Management System

Figure 2. 6 Elements of the Proposed Health Management System

C. Intensive Care

Expert doctors in the intermediate care unit, who remotely review the records of patients identify high risk patients who are likely to be hospitalised. The digitally transferred diagnostic inputs can keep the treatment process ready at the hospital so that the actual treatment can start immediately on patient reaching the hospital. This will minimize precious time loss, especially in cardiac emergencies. The patient is then transferred to a Case Manager who have significant expertise in intensive care units and thus used to cope with complex health care needs. These case managers plan personalised care plans in liasion with multidisciplinary panel of experts including doctors, pharmacists and other therapists to ensure appropriate treatment is provided that suits the patient's conditions.

D. Challenges

Despite potential benefits of Telemedicine, there are several barriers to the implementation across the health

industry like job fears, capital concerns, reimbursement issues, legal, ethical and liability concerns. There are needless fears of job losses among the health workers. Lack of ICT literacy in the rural areas has created a fear of handling computers, equipment and reluctance among doctors in adopting telemedicine. Studies have to be made that underscore the economic benefits and cost-effectiveness of implementing telemedicine. There is a lack of proper information access, storage and control mechanism. There is significant disagreement surrounding the determination as to which provider should be reimbursed for telemedicine services as well as what method of reimbursement is appropriate [7]. Thus the implementation, integration and improvement of telemedicine require development rigorous policies, procedures and strategies by various stakeholders across the healthcare value chain.
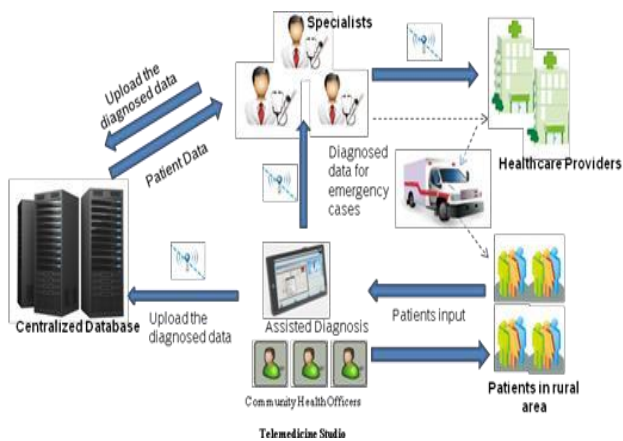

Figure 3. A model of the proposed Health Management System

IV. CONCLUSION

By embracing a coordinated effort in establishing a telemedicine network, applications can be extended to other diseases like Malaria, Dengue, Diarrhea, Blindness, Iodine deficiency and other such diseases, India can radically improve access to basic health care services throughout the country and provide life-saving services to people at low cost. Making this model scalable and sustainable will require significant and concerted efforts from both the public and private players in the medical and ICT sectors. There is an urgent need to address the legal and ethical issues concerning privacy and confidentiality of patients, responsibilities and liabilities in practicing Telemedicine. Nonetheless, the goal of improving health outcomes in India is now firmly within reach.

ACKNOWLEDGMENT

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AUTHORS' PROFILE

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APPENDIX I

TABLE I. MAJOR TELEMEDICINE INITIATIVES IN INDIA

Organizations	No of Centers Covered	Implemented Hospitals	Major Areas of Telemedicine Technology Adopted
Indian Space Research Organization	382 hospitals	AIIMS New Delhi, R&R New Delhi, SSKM Kolkata, AHF Kolkata, SGPGMI Lucknow, SRMC Chennai, SN Chennai, Apollo Chennai, AIMS Kochi, NH Bangalore, SN Bangalore, Apollo New Delhi.	Used for tele-ophthalmology, diabetic screening, mammography, childcare and community health. The Mobile Teleopthalmology facilities provide services to the rural population in ophthalmology care including village level eye camps, vision screening for Cataract/Glaucoma / Diabetic Retinopathy.
AIIMS	56 centers around india	AIIMS centers - AIIMS, SGI, PG etc.	Dermatology, Medicine, Orthopaedics, Nephrology, Cardiology, Cancer Treatment, Neurosciences etc…
NEC Telemedicine program for North-Eastern states	25 civilian Telemedicine centre under ISRO-NEC joint Telemedicine program and 6 Telemedicine centre in NER under Indian Army	Ram Krishna Mission Hospital Itanagar, General Hospital Naharlagun, Civil Hospitals, Guwahati Medical College & Hospital, Assam Medical College & Hospital, Jorhat Medical College & Hospita, Regional Institute of Medical Science (RIMS) Imphal, NEIGRIHMS Shillong, S.T.N.M. Government Hospital Gangtok, Sub- Divisional Hospital Dharmanagar, 151 Base Hospital Basistha, Military Hospitals etc.	Tele-consultation, Tele-monitoring of Public Health activites, Tele- diagnosis, Tele- treatment, Tele- education, Tele-training, Tele-monitoring, Tele- support etc.
Apollo Hospitals	150 telemedicine centers	Apollo has its own telemedicine centers in Delhi, Gandhinagar, Bengaluru, Chennai etc.	Tele-radiology, Tele-dermatology, Tele- cardiology, Tele- pathology, Remote ICU monitoring, Ambulance monitoring, Mobile Telemedicine Unit, Electronic Health Record.
State governments	13 states and union teritories.	Telemedicine facilities in Jammu & Kashmir, Andaman & Nicobar Islands, Lakshadweep Islands, North Eastern States, Karnataka, Kerala, Rajasthan, Maharashtra, Orissa, Chhattisgarh, adhya Pradesh, Andhra Pradesh, Punjab, West Bengal and Gujarat etc.	Tele-consultation, Tele-diagnosis, Tele- treatment, Tele- education, Tele-training, Tele-monitoring, Tele- support etc.
Dept. of Information Technology	-	Premier Medical Institutes like AIIMS New Delhi, SGPGIMS, PGIMER etc.	Tele-Cardiology, Tele-Radiology & Tele- Pathology

TABLE II.   TELEMEDICINE NETWORKS IMPLEMENTED IN VARIOUS STATES OF INDIA

NAME OF THE STATE GOVERNMENT	FUNDING AGENCY	NO. OF TELEMEDICIN E NODES	SPECIALTY HOSPITAL
Jammu and Kashmir	ISRO	12 District hospitals	Sher-e-Kashmir Institute of Medical Sciences Hospital, Srinagar
Himachal Pradesh	DIT	19 Health centers at district, block, and tehsil headquarters	IGMC Shimla and PGIMER Chandigarh
Punjab	DIT	20 District hospitals	Government medical college and hospital and five polyclinics of the state
Uttarakhand	State	2 District hospitals	SGPGIMS, Lucknow
North Eastern States	DIT	District hospitals each of seven North eastern states	Narayana Hrudayalaya, Bangalore
Jharkhand	ISRO	22 District hospitals	3 Medical colleges & hospitals
West Bengal	DIT	12 District hospitals	School of TropicalMedicine, NRS Medical College & Hospital, Kolkata, Burdwan Medical College & Hospital, Burdwan
Rajasthan	ISRO	32 District hospitals	6 State medical colleges
Chhattisgarh	ISRO	Two at medical colleges	Government medical colleges at Raipur & Bilaspur that further link to premier hospitals of the country
Orissa	ISRO, C- DAC	5 District Hospitals	3 Medical colleges that further linked with SGPGIMS
Karnataka	ISRO	26 District hospitals	Narayana Hrudayalaya, Bangalore
TamilNadu	State	6 District hospitals	Government General Hospital, Royapettah Hospital, Adiyar Cancer Center11—all at Chennai
Kerala	ISRO, C- DAC	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