TELEMEDICINE IN A TERTIARY CARE HOSPITAL IN SOUTH INDIA - A THIRTEEN YEAR REVIEW

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Abstract

Sri Ramachandra Hospital's telemedicine centre located in Chennai, South India, has been providing telemedicine services since 2001. This centre has grown in its use from providing tele-consultation to the three sub-centres of the hospital to expanding its reach to 19 rural centres and six hospitals. While in the initial years ISDN lines were predominantly used, the scope of practice widened to include rural areas with VSAT connectivity which was provided by the Indian Space Research Organisation. Today most of the tele-consultations are via IP connectivity. A hybrid model of using both store and forward (asynchronous) as well as real time (synchronous) tele-consultations and evaluations is practiced. Since November 2001 until December 2014, 21,565 tele-consultations were provided, wherein, 80% of the consultations were in super specialties like endocrinology, dermatology, neurology and nephrology. Further, tele-technology was used to strengthen Continuing Medical Education (CME) and so far 1900 CME programmes have been conducted. In 2009, CMEs and tele-consultations were extended to countries of the African Union through the Pan-African Network provided by the Government of India. The uniqueness of this centre lies in its scope of practice with respect to its revenue model, doctor-to-doctor consultation, and involvement in disaster management. Not only is the telemedicine centre used for clinical applications but also for continuing education and research. This article describes the functioning and activities of the Sri Ramachandra Telemedicine Centre.

Keywords: Tertiary care; telemedicine; multi-speciality; allied health; service

Introduction

The increasing need to apply Information and Communication Technologies (ICT) to provide healthcare services (eHealth) is well recognised, and its application has been explored in various disciplines. The motive and rationale for telemedicine activity in each country differs according to available resources and need. For example, in the USA, telemedicine has been extensively applied in the Veteran's Administration (VA) to facilitate access to healthcare for veterans and aims to take healthcare to homes.[1] Similarly, in UK, the National Health Scheme attempted a telemedicine model to monitor persons with disabilities and a range of other disorders.[2]

In India, a developing economy, the non-availability of super specialty services other than in major cities and towns, and the geographical distance in accessing such specialty care, has prompted healthcare providers to seek solution in telemedicine. The growing population and the stagnancy in number of specialists is likely to widen the gap of demand versus capacity in the years to come. According to a report by Quintiles IMS, appropriate healthcare includes; a) physical accessibility b) availability of the resources for diagnosis and treatment, c) quality and appropriate functioning of the resources, and d) affordability. In rural and semi urban areas, significant healthcare access challenges continue to exist for the Indian population.[3]

It is reported that 278 hospitals in India have been provided with telemedicine facilities, with 235 small hospitals, including those in remote and rural areas and medical college hospitals, connected to 43 speciality hospitals.[4]

Sri Ramachandra University and Hospital (SRU) Telemedicine

SRU is a tertiary care facility, with 1800 beds and 200 Intensive Care Units, providing healthcare for over 35,000 in-patients and 250,000 out-patients every year.

SRU has super specialities with state of the art infrastructure, and adopted telemedicine in 1997.

Initially, tele-consultations were offered only to the SRU sub-centres located in West Bengal, Karnataka, and Tamil Nadu. In 2002, the Government of India requested that services be extended to the Andaman and Nicobar islands, as they did not have any super speciality services. The Indian Space Research Organisation (ISRO) provided satellite connectivity and consultations were provided from SRU to GB Pant Hospital, in the Andaman and Nicobar islands. In 2004, the Village Resource Centre (VRC) network was inaugurated through ISRO's satellite link. Since then, the telemedicine activities of SRU have grown considerably, with more subcentres, addition of a mobile telemedicine van (satellite connectivity enabled), and an increase in the number of tele-consultations. Since SRU is a University and Hospital, telemedicine has played an important role in educational exchange as well.

SRU Telemedicine Infrastructure

SRU is connected to three sub-centres in the states of West Bengal and Assam, one in Sriharikota (SHAR) in the state of Andhra Pradesh, one in Andaman and Nicobar Islands, and one in Neyveli, in the state of Tamil Nadu. These centres are connected via ISDN lines and VSAT. In addition, six hospitals and 19 rural health centres, for example in Assam, Sullurpet, Imphal, Sringeri, and Nellore, have been provided with services based on their needs. One centre in Guwahati and one in Assam, is connected through VSAT due to lack of a robust alternate connectivity. The connectivity to the rural health centres are primarily via ISDN line as it is a 'pay per call' system and was economical for the end user.

Manpower

One engineer, with the qualification of Master of Science in Information Technology, coordinates the telemedicine activities of the hospital. Another person, with a Diploma in Electronics and Communication Engineering, assists in coordination within the hospital and with other centres. The sub-centres are manned by doctors (general practitioners) and tele technicians. On call support is available from the Audio-Visual Department, and the Department of Biomedical Sciences of the hospital. When the mobile telemedicine van is used, medical officers, nurses, and health workers serve as facilitators.

Hardware and software

The hardware includes two IP based video conferencing systems (Polycom and Sony), three flat screen LCD TV monitors, and two video cameras with tripod stands. Prognosys medical system's software is used for managing Electronic Medical Records, and a Picture Archiving Communication System (PACS) is used for radiology information transfer and archiving purposes. For better quality imaging, a Digital Imaging and Communications in Medicine (DICOM) viewer is used. In addition to software, email, fax, and cloud servers, are also used for sharing of medical records wherever applicable. The HL7 standard for patient data, medical status, quality monitoring, patient safety, diagnostic imaging is adhered to.

Connectivity

During the initial stages of telemedicine, ISDN connectivity, provided by the Bharath Sanchar Nigam Limited (BSNL; Government of India), was used with limited bandwidth of 128kbps**.** ISDN lines continue to be in use in remote locations where there is no IP connectivity or where the end user is unable to afford an IP connectivity. In 2004, VSAT-IP was provided by ISRO with a bandwidth of 384kbps, which expanded the scope of service, following which public IP was provided through Videsh Sanchar Nigam Limited (VSNL) with 512kbps, with another public IP, from BSNL, providing up to 2mbps also used. Since 2009, Airtel broadband with 2mbps bandwidth has been used for the Pan-African project. The National Knowledge Network (NKN) connectivity is provided by the Government of India, and is used for networking with educational institutions and hospitals in India.

Telemedicine model

At SRU a hybrid model of using both store and forward (asynchronous) as well as real time (synchronous) connectivity is practiced**.** Emergency and lifesaving procedures and tests are conducted in real time (ECG, ultrasound, CT scan) based on the requirement of the patient. The same tests are also conducted in store and forward mode, in a non-emergency situation. Consultations with super specialists are primarily real time.

Clinical applications of telemedicine

Telemedicine is incorporated into routine practice by various specialities of the hospital, including chest medicine, endocrinology, cardiology, dermatology, nephrology, neurology, neurosurgery, orthopaedics, obstetrics and gynaecology, and general surgery. Over 25 consultants from these super specialities are engaged in tele practice. Among these, approximately

35% consultations are in endocrinology, 15% in neurology, 15% in dermatology, 15% nephrology, 7% in chest medicine, 5% in neurosurgery, 5% are in cardiology and 3% in urology. Twenty percente of overall consultations are in general medicine. Telemedicine in super speciality areas is sought for in the North East, and Andaman and Nicobar Islands. In centres like Neyveli, consultations are predominantly for endocrinology and TB chest, as these conditions are more prevalent due to the presence of coal mines in this town. In general tele-consultations are provided either for initial diagnosis, post-operative follow-up, case discussions, and in emergencies where tele-surgical guidance is provided to the non-specialist at the patient end. In addition, mobile telemedicine services are provided in disaster relief and for rural health camps.

Tele-robot, a collaborative effort of SRU and Wayne State University and Robolytics, USA was used for patient monitoring in Neurosurgery ICU in 2013. It is a teleDroid 2 Autonomous Mobile Robot (AMR): a fourth generation' iPad, human-to-robot and robot-to-human interface, which enables text and audio to be delivered in multiple languages. It has the capabilities of an on-board laser guidance system that enables it to reliably navigate within the areas in which it provides service, locate and utilise alternative routes if necessary and circumvent moving and stationary obstacles in the ICU. It is used to monitor the level of consciousness, help in a patient's interaction with the consultant, and monitor blood pressure and pulse. In case of any abnormality the robot directly alerts the ICU staff.

Between November 2001 and December 2014, 21,565 tele-consultations were provided and 36,160 radiological images were transferred. In addition, 12,349 patients received services through the Mobile Telemedicine Service. The tele-consultations provided in each specialty during this time period are shown in Figure 1.

Only 5% of patients used telemedicine for their first time consultation with a super specialist, whereas 95% of patients used teleconsultations for subsequent follow-up or for post-surgical follow-up. This highlights an important trend in the application of telemedicine. On average, 100 teleconsultations are provided per month. The SRU telemedicine model is primarily a 'general practitioner (rural site) to super speciality doctor (tertiary hospital)' tele-consultation model, and since it is a University hospital the scope of work is governed by institutional guidelines.

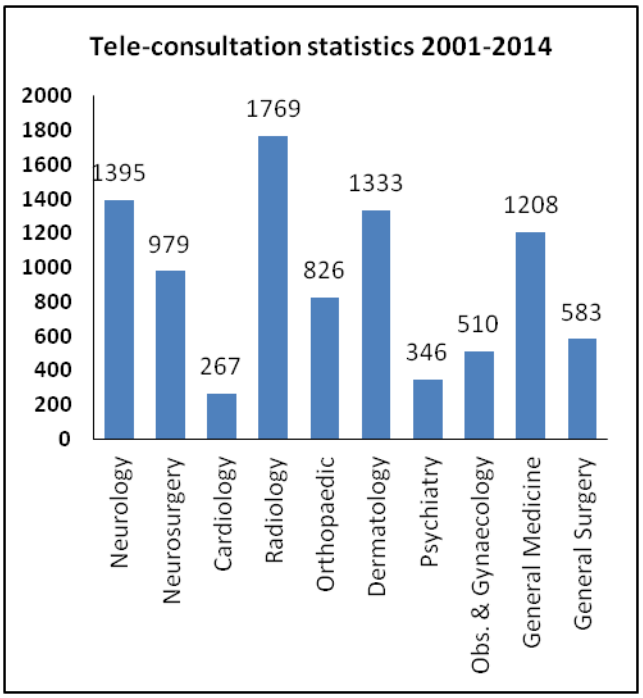

Figure 1. Tele-consultations provided in each speciality from 2001- 2014.

Examples of teleconsultations are shown in Figures 2 to 6. One particular strength of telemedicine lies in its robustness during disaster relief. VSAT was the only connectivity available during the 2005 tsunami in the Indian sub-continent, during which time four consultations were provided to Andaman and Nicobar Islands and SRU telemedicine provided several communication links for disaster relief. Telemedicine helped in saving lives by guided neurosurgery for a patient who met with a road traffic accident, one general surgery case, and one case of high risk pregnancy in Andaman and Nicobar Islands. Nine patients with myocardial infarction were revived in different sub-centres by guiding local doctors.

Other than tele-consultations, procedures, both real time and store and forward are also carried out. For example, at Sriharikota hospital, ECG, and ultrasound for obstetric and gynaecological investigations are conducted real time by a consultant from SRU hospital with the help of a general practitioner at the far site. In the North-East centres of India, radiological images, ECG, and ultrasound are recorded, stored, and forwarded. Store and forward is also practised for radiological and blood investigations with the Neyveli Government Hospital, Tamil Nadu.

A review of compliance to follow-up for tele-

Figure 2. Tele-plastic surgery post-op consultation.

Figure 3. Tele-audiology real time testing in a mobile tele-van for a newborn in Thirukazhukunram, Tamil Nadu, India.

Figure 4. Figure 4. Telcardiology consultation given to a patient at Siliguri, West Bengal.

medicine consultations showed that there was 70% follow-up for a face-to-face consultation when surgical intervention was recommended, and there was 100% compliance for a 2nd follow-up via tele-consultation. For example, at the Neyveli Government Hospital, consultations are provided for nephrology, chest medicine and endocrinology. These patients require

Figure 5. Tele-obstetric consultation for a patient with high risk pregnancy at SHAR, Sriharikota.

Figure 6. Tele-pulmonology consultation given to a patient in Neyveli, Tamil Nadu.

two tele-consultation follow-ups in the first month and subsequently are required to follow-up once in three months. It was found that less than 10% of the patients missed any of the tele-consultation follow-up.

Mobile telemedicine was started in 2008 with the support of ISRO. The mobile van covered villages within a 50 km radius of SRU as part of the hospital's initiative to provide community service. The mobile van was equipped with ultrasound, a drug store, a laboratory testing facility, and an ECG. A medical officer, staff nurse, and tele-technician travelled in the van. Medical and dental camps were conducted using the mobile van. However, the mobile telemedicine van service was not found to be sustainable due to high maintenance, and other related costs, and was used only when providing services to remote rural areas with no broadband internet connectivity.

Revenue model

SRU telemedicine provides services to Government centres as well as SRU sub-centres. At the sub-centres, patients pay for any tests or consultation as applicable (for example, centres at West Bengal and Assam).

When services are provided at Government hospitals, like Srihari Kota or GB Pant Hospital, the patients are not charged for the service. With some hospitals like Neyveli hospital, they are covered under the central government health scheme and therefore, the consultation costs are compensated by the Government.

It must be emphasised here that, in the absence of telemedicine, the Government would have had to pay for the patient's commute and local accommodation, in addition to the hospital charges, as part of compensation for their employees. Though no data are available, it can be surmised that the use of telemedicine technology has resulted in cost savings for the Government as they only pay for the telemedical consultation. Further the employee's work hours lost due to travel to distant hospitals has been reduced.

Application of tele-technology in education and research

The Government of India provided the National Knowledge (NKN) Network to promote and facilitate information exchange between the various medical institutions of the country. General broadband through the National Informatics Centre is used to connect with district hospitals. The NKN network is a dedicated line used for Continuing Medical Education (CME) programmes, live surgery, workshops, and conferences. In case of point-to-point connectivity, a 1 Mbps line is used to conduct CME and for live surgery and workshops a minimum of a 2 Mbps line is utilised.

SRU telemedicine has engaged in academic activities with 20 national institutions, and tele-educational activities with nine International Centres. Figure 7 shows the CME programme statistics since 2000.

In all, 1900 CME programmes, including multi-conferencing and point-to-point conferencing were conducted. In addition, two Continuing Nursing Education (CNE) programmes were conducted using VSAT connectivity.

The Government of India also supported the Pan African e-Network in 2009. The goal was to connect to 53 countries of the African Union of which 38 were eventually connected. This network is used for both tele-education and telemedicine. An average of seven CME programmes per month have been conducted on this network since 2009, and telemedicine consultations have also been conducted with several hospitals in the African Union. Nineteen countries have actively participated over the years through this network.

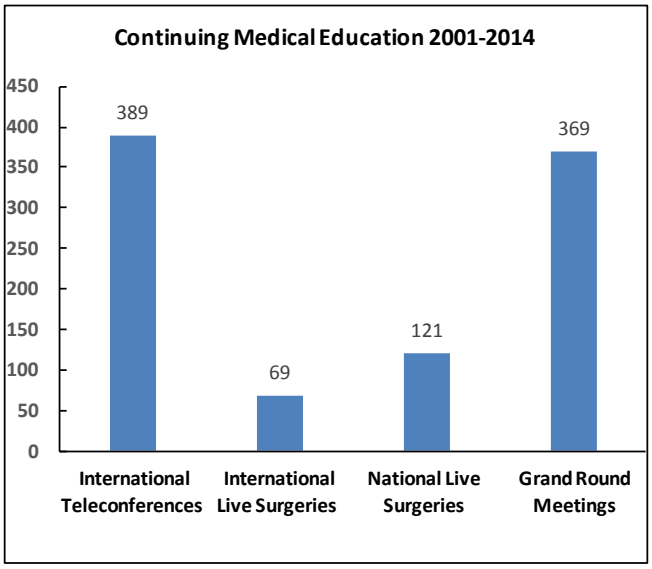

Figure 7. CME programme statistics.

Conferences

The first Pan-Asian Neurosurgical Telemedicine conference took place in 2001 and connected four Asian countries (Japan, Singapore, Hong Kong, and India (SRU)). This was the first of its kind in the Asian setting. An International teleconference was also conducted on speech and language difficulties for individuals with cleft, lip, and palate disorders by SRU's Department of Speech, Language and Hearing Sciences along with Loma Linda University, California, USA in 2006. Recently, a workshop on tele-audiology and speech-language pathology was held with resources from Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow and independent practitioners in Pune participating via tele-conference in 2015. Other conferences, seminars, and workshops conducted by SRU include: Grand Round Meetings since 2002, workshops and guest lectures since 2003, a physician's conference in 2006, Clinical Society Meetings since 2008, and a Tumour Board Meeting in 2010 (Oncology).

Research

A project on community based infant and young children's hearing screening using tele-audiology was conducted from 2010-2013 with the funding of the Indian Council of Medical Research. This project helped in understanding the cost-effectiveness of tele-audiology applications, in addition to their feasibility and outcomes.

Conclusion

Several reasons contribute to the success of a telemedicine programme. Adoption of telemedicine by clinicians plays an important role in the success of any tele-activity. In addition, institutional support and interest to take telemedicine to the next level is pertinent. A key area of need is in building robust revenue models for telemedicine. Several such recent attempts have brought more clinicians to telepractice. Availability of technologist's 24/7, availability of different types of bandwidth, and good quality videoconferencing are other factors for telemedicine acceptance. To keep up with the growing need it will be important to introduce telemedicine into the curriculum for medical education.

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Acknowledgements. Mr. Satheesh Kumar, Engineer, Telemedicine Centre, Sri Ramachandra University, Porur, Chennai for his assistance in retrieving data regarding SRU-Telemedicine programme

Conflict of Interest. The authors declare no conflicts of interest.

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