Review Article

Telehealth in India: The Apollo contribution and an overview

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ABSTRACT

The universal phenomenon of urban rural health divide is particularly striking in India. We have centres of medical excellence in the metros, better than the best. However 700 million Indians, have no direct access to secondary and tertiary care as 80% of India's specialists, primarily cater to 20% of the population. Additional brick and mortar hospitals is not a viable solution, as there is an acute shortage of both funds and health care personnel. In 1999, the author among others, foresaw that it could be possible, to extend the reach of urban doctors to suburban and rural India, virtually. This article traces the author's personal experience in introducing and developing telehealth in India over the last 14 years.[1–8] Simple video conferencing, has given way to eHome Visits,[10–12] providing international teleconsults,[13,14] tele CME programmes,[15–17] deployment of internet enabled peripheral medical devices, promoting Health Literacy through eEmpowerment,[18,19] multi centre Grand rounds and, virtual visits to the ICU.[20–22] With 894 million mobile phones mHealth is certainly the future.[23] The Pan African, SAARC, ASEAN and the Central Asia e Network projects[13,14,24–29] initiated by the Govt. of India has resulted in India's health expertise, being made available to many countries virtually. With exponential growth in Information and Communication Technology (ICT), a rural tele-density of 43%,[23] India may eventually show the way to achieve quality, affordable, accessible health care to everyone, anytime, anywhere making distance meaningless and Geography History, by deploying telemedicine.

"All people, no matter where they live, have a right to access high quality, affordable healthcare."

"A solution is not a solution, unless it is available to everyone, everytime, everywhere"

1. Introduction

Telemedicine is a term encompassing all methods used to examine, investigate, monitor and treat, with the patient and doctor, physically located in different places, transferring the expertise. Unnecessary travelling of patients and escorts is eliminated. Image acquisition, storage, display, processing, and transfer, form the basis of telemedicine. In the last few

years telehealth (a more inclusive term) has grown exponentially. India, considered a developing country, is however a paradox. We produce and launch our own satellites, plant a flag on the moon[30] and have sent an unmanned mission to Mars.[31] We have centres of medical excellence better than the best. In 2012, 200,000 patients came to India from overseas, for health care, spending 2.3billion$.[32] However 700 million Indians, have no direct access to secondary and tertiary care, having to travel 40–100 km. The National eGovernance Plan has mGovernance as a major division showing the unprecedented growth and development in ICT. India neither follows nor piggy backs on advanced countries, we leap frog! Setting up telecommunication infrastructure in rural areas, to increase reach of urban specialists, is easier than making available specialists physically. Knowing that a specialist is only a mouse click away, does wonders for one's morale. Digital information is also easy to disseminate, widely available, relatively inexpensive and can level the playing field.

2. History of Apollo telemedicine

Clinical telemedicine was formally initiated in South Asia, when the world's first VSAT enabled village hospital, at Aragonda, a village in Andhra Pradesh a state in South India, where Dr Prathap C Reddy Founder Chairman of the Apollo Hospitals Group was born, was commissioned on March 24th 2000 by the then US President Bill Clinton. Speaking on the occasion Clinton remarked "I think it is a wonderful contribution, to the healthcare of the people living in villages. I hope that people all over the world, will follow your lead so that the benefits of hi tech medicine will go to everyone and not just those who live in big cities".[33] Over the last 14 years with 135 centres including 15 overseas, Apollo Telemedicine has become the largest and oldest multi speciality Telemedicine Network. In addition telehealth, is already being provided as a pilot, by Apollo in 225 Common Service Centres of the Dept of Electronics and Information Technology, Govt of India.[34] Ultimately the government expects to commission 100,000 such internet enabled kiosks. Over 80,000 teleconsultations have been provided in 25 specialities for distances from 100 to 4500 miles. Apollo Telemedicine Networking Foundation is a Not for Profit Company whereas Apollo Telehealth Services is the commercial arm. ATNF was the first to provide proof of concept validation studies in remote diagnosis using wireless 3G technology[35,36] and to start a Telehealth Technology Course in conjunction with the Anna University.[37,38] As a member of the National Task Force on Telemedicine, ATNF played a significant role in formulating initial policies. In 2007 an International Telemedicine Conference was organized in Chennai.[39,40] With over 200 presentations in regional, national and international conferences and over 100 publications[1,2,4–8] ATNF has even been cited in a European Atlas of Telemedicine History.[41] The author also initiated the use of telemedicine in neurosciences.[42–49] Harvard Business school, Wharton School of Business, the London School of Economics, Indian school of Business are among some of the several international organisations who have used Apollo Telemedicine as study material[50–52] Home telecare and electronic house visits have been initiated. The latter initiative was recognised with a special award at the 8th Annual World Healthcare Congress held in Washington in 2012.[10–12] An in house, custom built Medentegra software which in addition, to a user friendly EMR (facilitating uploading of images, investigations etc.) has inbuilt video conferencing capabilities has recently been introduced. The widely used eDoc[53] virtual booking service will soon be extended to virtual teleconsults as well. The teleradiology service[54,55] ensures a turn around time of 4–6 h (45 min for emergencies). From 2009, 190 grand rounds in six specialities, have been conducted between different Apollo hospitals using multipoint VC. 21 clinical meetings and conferences with multiple overseas centres have been carried out in addition to webcasting complex unusual surgical procedures.[56–58] Attempts are being made to deliver health care in rural India as well.[59–62]

2.1. Virtual visits to ICU

I-SEE-U®[20–22] is a state of the art solution to enable virtual visits to ICU patients, from anywhere in the world, by authorised consultants, friends and relatives. Reduced physical visits leads to better infection control. Simultaneously, this facilitates additional ICU visits. The remotely enabled networked camera in the individual ICU cubicle can also focus on the various monitors. Commissioned recently, the six hundred thirty five users have given an excellent feedback.

3. eICU

eICU's[63,64] where smaller ICU's are connected to highly trained experienced intensivists in larger ICU's are now a reality in the state of Tamilnadu and some other states. Expert advice to physicians, bedside staff and patients for management of critically ill patients in smaller ICU's and initiation of mechanical ventilation or non- invasive ventilation, and haemodynamic monitoring support are provided.

4. Tele ophthalmology

In 2013 alone, 306,170 teleconsultations were done in the *Aravind Eye System* including 190,878 new and 115,292 review patients.[65] Sankara Nethralaya has carried out **461,724 teleconsults from Oct 2003**[66] The Tripura Vision Centre program is a Public Private Partnership program with the Department of Health & Family Welfare and the National Program for Blindness Control. (NPCB) covering a population of 300,000. Remote teleophthalmic services to rural areas have been successfully carried out[67,68] Ophthalmologists in Karnataka in South India use their iPhones to screen infants in rural and semi-urban areas for retinopathy of prematurity.[69]

5. Tele education and the National Medical College Network

The Ministry of Health, Govt. of India is interlinking medical colleges across the country thro a National Medical College Network (NMCN)[70,71] for common e-Education. National

Resource Centers and Regional Resource Centers for NMCN have been identified. High speed optic fibre based internet bandwidth up to 1 Gigabyte per second is being deployed under the National Knowledge Network Project initially in 150 medical colleges. More than 500 grand rounds have been carried out between the various tertiary Apollo Hospitals using multi point video conferencing with an in-house Bridge. Apollo Hospitals, Chennai is one of the 10 superspeciality hospitals in India connected to 39 countries in Africa under the Govt of India Pan African e-Network project. 2500 lectures have been delivered for doctors in Africa through this network.[72] The School of Bioinformatics and Telemedicine located at the SGPGI Lucknow (Sanjay Gandhi Postgraduate Institute of Medical Education and Research) is the National Resource Centre for Telemedicine. Under the leadership of Prof Saroj Mishra the School is playing a major role in tele education in the health sector. A wide variety of papers have been published[15–17,73–85] encompassing telementoring and tele training in surgery and surgical endocrinology.

6. The National telehealth scenario

Today there are about 600 telemedicine units mostly in the suburbs. Though utilisation is suboptimal, there is optimism. Several publications[9,86–101] have reviewed the specific problems encountered in setting up telemedicine units in different areas, use of telemedicine in giant gatherings e.g. the Kumbh Mela where 120 million people congregated in 2013. Teleconsults originating from India to other countries through the government and the private sector has been in vogue for several years. Introducing telemedicine in the medical/IT curriculum and passing a Telehealth Act of India is awaited. The rise of internet use in India and the health implications has been commented in the British Medical Journal.[102] It has been proposed that as rural India will soon be *internet ready*, the acute shortage of healthcare providers could be addressed by mandatory "Virtual Rural Postings" for urban located health care personnel.[103] A valuable by-product, if this innovative suggestion is implemented, is that tens of thousands of urban doctors using cutting edge technology, would gain an insight into, and appreciation of problems in rural areas. Constant virtual access to experienced urban specialists will also benefit the rural healthcare provider eventually increasing the latter's level of competence. A carrot and stick policy with incentives and disincentives needs to be implemented.

7. Telemedicine enabled Hospital on Wheels

There are about fifty five operational "Hospital on Wheels" (HoW) Many of them are VSAT enabled. A villager gets into an air-conditioned mobile truck which has an ultrasound, X-ray, echocardiogram, ECG, biochemistry laboratory, ophthalmic equipment etc. A technician focuses the ophthalmoscope into the eyes of the patient, and the image of the fundus is evaluated by the teleopthalmologist in the tertiary care centre.[65,66] Through internet or a VSAT on the truck, video conferencing and transmission of images is enabled. While many HoW's are dedicated to ophthalmology, diabetology and psychiatry multi purpose HoW's are also available. In a first of its kind initiative, 527 patients in 13 different specialities were connected simultaneously to six tertiary Apollo hospitals, in different parts of India from a HoW at a mega health camp held at Ajmer in Northern India on 11th and 12th February 2012. Remote clinical evaluation was followed by ePrescriptions. Subsequently similar telecamps were held in different parts of Tamilnadu in southern India.[104,105]

8. The national ICT scenario

Information and Communication Technology is growing exponentially with rural tele-density approaching 48%. The Govt. of India's National Telecom Policy envisages even a 'Right to Broadband' scenario by 2020.[106] The United Nations has already declared access to the Internet a human right. A government funded fibre optic network connecting 250,000 villages launched in October 2011 when complete could truly transform remote healthcare delivery.

8.1. mHealth

In August 2007 the author was requested by Ericsson, to study for the first time in South Asia, the feasibility of doing remote clinical examinations entirely thro' wireless connectivity.[35,36] In July 2008 The Rockefeller Foundation organised a *Making the eHealth Connection* Conference at Bellagio Italy[107] The author presented a paper on " mHealth: A potential tool for Health care delivery in India".[108] The term mHealth was conceptualised here for the first time. None could have forseen the phenomenal explosion of mHealth or the utilisation of smart phones in the "third world". With 894 million phones,[23] mBanking, mEntertainment, mCommerce and mGovernance are becoming a reality, but mHealth today is conspicuous by its relative absence. Pilots and proof of concept studies in various aspects of mHealth are abounding in India. Hundreds of thousands of SMSs sent every day by government health departments, NGOs and the private sector are ensuring better adherence and compliance be it for immunisation, vaccination, ante natal counselling, or blood sugar evaluation. Medical Call centres are providing authenticated validated health information through mobile phones. Thousands of health "apps" can now be downloaded. VC through mobiles, using 3G and eventually 4G is on the anvil. The author among others, thro publications and presentations, are creating awareness on the untapped potential of mHealth in India.[109–119] The transformative potential of mHealth in India, however hinges on its acceptance and use. A multilingual field survey was carried out by the author between Oct 2012 and April 2013. 1886 valid responses were analysed (69% urban and 31% rural). 46% of the urban sample had smart phones vs 22% in rural areas. 72% in urban and 48% in rural areas were aware of mHealth. 55% (urban and rural) showed a *very strong intent to use mHealth*. The study[120] revealed that Rural and Urban India appear to be ready to use mHealth but the solutions need to be customised. Utilisation depends on education, empowerment and building trust. With 15 million broadband connections, 35 million internet subscribers 100 million PC's but 894 million mobile phones, mHealth is obviously more relevant in India.

9. Technical issues

Effective delivery of telehealth services requires maintaining standards with reference to privacy, authentication, confidentiality, telecommunications, records, authorised access to patient data, encryption, guaranteed reliability, interpretability, legal obligations, multimedia applications, performance levels and security. This must be an *ongoing process*. Interoperability of systems, compatibility and scalability are a must. Constant benchmarking of equipments is required meeting international DICOM standards. Several publications from India have addressed these and other allied issues.[121—134] Standardising, certifying, authenticating and registering telemedicine units to ensure uniformity is the next step.

10. Patient empowerment in rural India

Health Literacy is critical in improving health outcomes. Deploying multi point Videoconferencing the author has initiated a knowledge empowerment programme at the internet enabled Village Resource Centers of the MS Swaminathan Research Foundation in rural Tamilnadu.[18,19] Consultants interacted with 6050 villagers in 18 villages. The Q & A interactive sessions were stimulating. Using MCQ's, knowledge levels were measured. The modest increase of 20% was attributed to unfamiliarity with the MCQ model. Feedback was excellent. Use of visuals and videos made the interaction more meaningful. More important, was the subsequent discussion the attendees had, with those who were unable to partake.

11. Global telehealth initiatives of Govt of India

The Ministry of External Affairs, Govt. of India initiated the Pan Africa e-Network project for teleconsultations in 2009[3,13,14] Through this network Apollo Hospitals Chennai is connected to 39 countries in Africa. The SAARC e-Network[24,25] for South Asian Countries and the ASEAN[26] network is being followed by the Central Asia e-Network Project.[27—29] The 5 Central Asian CIS countries Uzbekistan, Kazakhstan Kyrgyzstan, Turkmenistan and Tajikistan will be connected to India for Telemedicine and Tele-education services for five years. Five reputed Universities and Superspeciality Hospitals in India will be connected through a dedicated network, to a Study Centre/ICT Resource Center and a leading hospital, in each CA country. This hospital may further connect to their secondary hospitals in remote areas. Post Graduate, Under Graduate, Certificate and Diploma Programs in various disciplines through distance education via on-line teaching hosted at each of the Indian Universities will be made available.

11.1. Social and ethical issues

For telehealth to be integrated into the health care system, social, ethical and legal issues need to be addressed. Organisational matters, absence of a self sustaining/revenue generating model and human factors, not technology, are the deterrent factors. Traditionally socio-economic factors, geography, age, education, cultural and ethnic beliefs are considered in a face to face doctor - patient encounter. With telemedicine, the healer could be in Chennai and the *to be healed* in Uzbekistan !!. Telehealth should not result in depersonalization or diminish trust. Tele diagnosis must be followed with appropriate referrals for investigations and subsequent management. Producing cost effective appropriate technology, hardware and software and ensuring connectivity alone is insufficient. Short term courses to train trainers and users, reimbursement (teleconsults quadrupled in USA when insurance companies reimbursed teleconsults), getting grants, subsidies and waivers to introduce telehealth is necessary.

12. Conclusion

Accessible quality healthcare to anyone, anytime anywhere at affordable cost, will be the new mantra. The most important enabler to make these breakthroughs come true, is not further advances in technology, but meticulous attention to WiiiFM for every single stakeholder in the entire ecosystem. The question "What Is In It For Me" has to be satisfactorily addressed. A solution is not a solution unless it is universally accepted and available. With private players playing the major role, particularly in secondary and tertiary health care it behoves them to extend their reach and provide health care particularly where it is not available.

Conflicts of interest

The author has none to declare.

REFERENCES

1. Ganapathy K. Medical informatics around the world universal publishers: Barnes & Noble [Chapter on India]. In: Steele A, ed. Universal-Publishers; 2002. ISBN -10: 1581126344 ISBN -13: 978581126341 http://www.upublish.com/books/steele3.htm.
2. Ganapathy K, Aditi R. Telemedicine in India- the Apollo story. In: *Proceedings of Med-e-Tel Conference*. April 2007:7—14. Luxembourg http://www.medetel.eu/download/2007/Med-e-Tel_2007_Proceedings_CD.pdf.

3. Ganapathy K. Telemedicine in the Indian context. An overview. In: Latifi Rifat, ed. *Establishing Telemedicine in Developing Countries: From Inception to Implementation*. Studies in Health Technology and Informatics; vol. 104.

4. Ganapathy K. Telemedicine in India. In: Steele Andrew, ed. *Medical Informatics Around the World*. Universal Publishers; 2002. ISBN-13: 9781581126341Universal-Publishers 2002.

5. Ganapathy K. Telemedicine in India. *Asia Pac Biotech News*. 15 October 2006;10(19). http://www.asiabiotech.com/readmore/vol10/1019/telemed.html.

6. Ganapathy K, Aditi R. Evolution of telemedicine in India. In: *Proceedings of Med-e-Tel Conference*. April 2007:347–352. Luxembourg http://www.medetel.eu/download/2007/Med-e-Tel_2007_Proceedings_CD.pdf.

7. Ganapathy K. *Interview – Asian Hospital & Healthcare Management*. 4th ed. Healthcare and IT; Jan 2009:60–62.

8. Ganapathy K. *Guest lecture "Telemedicine in India; An Overview" at the Special Interest Group at the Annual Conference of the American Telemedicine Association Tampa Florida USA*; May 1st 2011. http://www.youtube.com/watch?v=BKndp1MhodU.

9. Ganapathy K. Telemedicine in the Indian context: an overview. *Stud Health Technol Inf*. 2004;104:178–181 [PubMed].

10. *Home Telecare and Telenursing*. http://www.accessh.org/CaseStudies_Pdf/ATNF.pdf.

11. http://www.ncbi.nlm.nih.gov/pubmed/19659414.

12. http://profit.ndtv.com/stock/apollo-hospitals-enterprise-ltd_apollohosp/reports.

13. www.panafricanenetwork.com.

14. www.mea.gov.in/Portal/…/Pan_African_e_docx_for_xp.pdf.

15. Misra UK, Kalita J, Mishra SK, et al. Telemedicine for distance education in neurology – preliminary experience in India. *J Telemed Telecare*. 2004;10(6):363–365.

16. Singh K, Mishra SK, Misra R, et al. Satcom based distance education in medicine – evaluation of Orissa telemedicine network. In: *6th IEEE Healthcom 2004, Odawara, Japan*. 28–29 June 2004.

17. Sushma A, Maurya AK, Srivastava K, et al. Training the trainees in radiation oncology with telemedicine as a tool in a developing country: a two year audit. *Int J Telemed Appl*. 2011. http://dx.doi.org/10.1155/2011/230670.

18. http://www.telemedicineindia.com/mssrf.html.

19. http://www.transformhealth-it.org/2nd%20Day%20(07-Sep)%20-%20THCIT%202013%20Program%20Schedule.pdf.

20. http://www.apollohospitals.com/virtual_visit.php.

21. No need to visit, you can see patients through 'I-See-U' http://www.thehindu.com/news/national/tamil-nadu/no-need-to-visit-you-can-see-patients-through-iseeu/article5190555.ece.

22. I-SEE-U. *Pragmatic Visits to ICU from Everywhere in the World*; October 10th, 2013. http://ictpost.com/health-directory/?p=682.

23. http://www.trai.gov.in/WriteReadData/WhatsNew/Documents/Press%20Release%20on%20'Telecom%20Subscription%20Data%20as%20on%2031st%20January,%202014'.pdf.

24. http://www.saarctf.org/.

25. http://journals.sfu.ca/apan/index.php/apan/article/viewFile/54/pdf_54.

26. http://www.sgpgi-telemedicine.org/PPT/Rural%20Connectivity%20Conference_SKM.pdf.

27. http://indiatoday.intoday.in/story/india-to-create-e-network-for-central-asia/1/200042.html.

28. http://en.wikipedia.org/wiki/India%E2%80%99s_%E2%80%98Connect_Central_Asia%E2%80%99_Policy.

29. www.jdwnrh.gov.bt/?page_id=69.

30. http://www.isro.org/pressrelease/scripts/pressreleasein.aspx?Nov14_2008.

31. http://www.isro.gov.in/pressrelease/scripts/pressreleasein.aspx?Feb11_2014.

32. http://www.medicaltourismresourceguide.com/medical-tourism-in-2013.

33. http://www.apollohospitals.com/hospitals/hospital-in-aragonda.php?city=aragonda.

34. http://www.indiamedicaltimes.com/2013/11/14/apollo-hospitals-signs-mou-with-csc-to-provide-telemedicine-services-in-rural-india/.

35. http://www.rediff.com/money/2007/sep/21eric.htm.

36. http://www.slideshare.net/smruti009u/m-health-presented-by-dr-k-ganapathy.

37. http://www.ciol.com/ciol/news/117953/apollo-initiates-telehealth-courses.

38. http://www.annauniv.edu/course/telehealth.pdf.

39. http://telecentre.eletsonline.com/2007/03/chennai-india-to-host-international-conference-on-telemedicine-3/.

40. http://www.thehindu.com/todays-paper/tp-national/tp-tamilnadu/chennai-to-host-international-meet-on-telemedicine/article1806092.ece.

41. Dumanskyy YuV, Vladzymyrskyy AV, Lobas VM, et al., eds. *Atlas of the Telemedicine Historyp 65*. Donetsk: Publishing House «Knowledge»; 2013. ISBN 978-617-579-596-5.

42. Ganapathy K. Telemedicine and neurosciences in developing countries. *Surg Neurol*. 2002;58:388–394.

43. Ganapathy K. Role of telemedicine in neurosciences. In: *Progress in Clinical Neurosciences*. vol. 17. 2002:1–10.

44. Ganapathy K. Management and prevention of head injuries in India using telemedicine. In: Monduzzi Wirjomartani BA, ed. *ICRAN 2002 – International Conference on Recent Advances in Neurotraumatology Bali 1*. International Proceedings Division. Aug 2002. ISBN:978-88-3232-801.

45. Ganapathy K. Telemedicine in the management of head trauma: an overview. *Indian J Neurotraumatol*. July 2004;1:1–7.

46. Ganapathy K. Role of telemedicine in neurosciences. In: Latifi Rifat, ed. *Establishing Telemedicine in Developing Countries: From Inception to Implementation*. Studies in Health Technology and Informatics; vol. 104.

47. Ganapathy K. Telemedicine and neurosciences. *J Clin Neurosci*. Nov 2005;12(8):851–862.

48. Ganapathy K. Telemedicine in neurology: underutilized potential. Letters to the editor. *Neurol India*. 2005;53:242. http://www.neurologyindia.com/article.asp?issn=0028-3886;year=2005;volume=53;issue=2;spage=242;epage=242;aulast=Ganapathy.

49. Ganapathy K, Aditi R. Telemedicine in neurosciences. In: Latifi Rifat, ed. *Current Principles and Practices of Telemedicine*. IOS Press; January 2008:149–169.

50. Raja B. Apollo telemedicine networking foundation: a case study. Access Health International Centre for Emerging Markets Symposium Indian School of Business Hyderabad http://www.accessh.org/CaseStudies_Pdf/ATNF.pdf.

51. *Can Telemedicine Alleviate India'Health Care Problems?* Published: March 08, 2012 in India Knowledge@Wharton http://knowledge.wharton.upenn.edu/india/article.cfm;jsessionid=a830c2b096752beab04b3b561e666d1a6548?articleid=4675.

52. https://www.apollohospitals.com/international_patient_services/news_detail.php?newsid=204.

53. http://www.apolloedoc.co.in/.

54. http://www.indiamedicaltimes.com/2014/01/06/apollo-hospitals-launches-teleradiology-service/.

55. http://www.thehindu.com/news/cities/chennai/apollo-hospitals-launches-teleradiology-services-in-chennai/article5546260.ece.

56. http://www.apollohospitals.com/news_detail.php?newsid=473.

57. http://www.thehindu.com/news/cities/chennai/separated-pygogapus-twins-to-fly-home-today/article5703447.ece.

58. live webcast http://www.apollohospitals.com/conjoint-twins-webcast.php.

59. Ganapathy K. Telemedicine: express health care management. 16-28 February 2005;6(3). http://expresshealthcaremgmt.com/20050228/interview03.shtml. http://expresshealthcaremgmt.com/20050228/telemedicine02.shtml.

60. Ganapathy K. Introduction to telemedicine. In: *Talk Given at the Inauguration of the ISHa Foundation Rural Telehealth Clinic at Aladorai*; Feb 19th 2012. Coimbatore Didt http://www.skyscrapercity.com/showthread.php?p=88710516.

61. Ganapathy K. *Invited Talk in Session on "Innovative Technologies for Rural Development" at the 8th Convention of Grameen Gyan Abhiyan Organized by the National Alliance for Bridging the Urban-rural Digital Divide M.S.Swaminathan Research Foundation, Chennai*; 29th October 2012. http://mission2007.in/Agenda_GGAConvention.html.

62. Ganapathy K. *Guest Lecture: "Relevance of EHealth in a Health Microinsurance Environment" at IFMR Research, Chennai*; 20–21 July 2011. http://cirm.in/events/conferences/health-microinsurance-forum-http://www.youtube.com/watch?v=EqQ-jbKpWc&feature=related. http://www.cirm.in/events/micro-health-insurance-forum-2011.

63. *eICU to the rescue of remote hospitals.* http://www.thehindu.com/sci-tech/technology/eicu-to-the-rescue-of-remote-hospitals/article3997161.ece.

64. http://www.indiamedicaltimes.com/2013/07/06/tele-icu-a-new-paradigm-in-critical-care/.

65. http://www.aravind.org/.

66. http://www.sankaranethralaya.org/teleophthalmology-camp-statistics.html.

67. http://www.youtube.com/watch?v=dqVCnd8PPCU.

68. http://www.indiagovernance.gov.in/bestpractices.php?id=932.

69. http://dpar.kar.nic.in/dparar/KIDDROP%20NOTE.docx.

70. http://www.telemedindia.org/MoHFW4.html.

71. http://nmcn.in/.

72. http://www.indiamedicaltimes.com/2014/01/03/guest-article-can-ict-make-a-difference-in-providing-healthcare-by-dr-k-ganapathy/.

73. Singh K, Mishra SK, Misra R, et al. Strengthening postgraduate medical education in peripheral medical colleges through telemedicine. *Telemed J E Health.* 2004;10:S 55–S 56.

74. Mishra SK. *Application of Telemedicine in Surgery: Telemedicine Manual.* Bangalore: Indian Space Research Organization; 2005:83–90.

75. Kapoor L, Mishra SK, Singh K. Telemedicine: experience at SGPGIMS, Lucknow. *J Postgrad Med.* December 2005;51(4):312–315.

76. Pradeep PV, Anjali M, Kapoor L, et al. Case study with endocrine surgery. In: *Proceedings of 8th International Conference on e-Health Networking, Applications and Services, Healthcom 2006.* New Delhi, India: IEEE; 17-19 August 2006:78–83. ISBN: 1-4244-9704-5 © 2006.

77. Mishra SK, Mishra A, Pradeep PV. Telementoring in endocrine surgery.;Telesurgery. In: S Kumar, Marescaux J, eds. Heidelberg/Germany: Springer-Verlag GmbH; 2007. ISBN 978-3-540-72998-3.

78. Mahapatra AK, Mishra SK. Bridging the knowledge and skill gap in healthcare: SGPGIMS, Lucknow, India initiatives. *J eHealth Technol Appl.* June 2007;5(2):67–69.

79. Pradeep PV, Mishra A, Mohanty BN, et al. Reinforcement of endocrine surgery training: impact of telemedicine technology in a developing country context. *World J Surg.* 2007. http://dx.doi.org/10.1007/s00268-007-9108-1.

80. Indra PS, Kapoor L, Chand RD, et al. Integrating telemedicine in surgical applications. *CSI Commun.* February 2007;30(11):17–20.

81. Pradeep PV, Anjali M, Kapoor L, et al. Application of tele-health technology in endocrine surgery: Indian experience. In: *Proceeding: International Association of Science and Technology for Development (IASTED).* 31st May–1st June, 2007:13–16. ISBN:987-0-88986-667-6, Montreal, Quebec, Canada.

82. Mishra SK, Pradeep PV, Anjali M. *Tele-mentoring in India: Experience with Endocrine Surgery*In: *Telehealth in the Developing World.* 2008:109–118. ISBN 978-1-85315-784-4.

83. Mahapatra AK, Mishra SK, Kapoor L, et al. Critical issues in medical education and the implications for telemedicine technology. *J Telemed eHealth.* August 2009;15(6):592–596.

84. Vikas A, Ramnath M, Amita A, et al. Impact of teleducation and teleconsultations in clinical immunology. In: *Proceeding: 4th National Conference of Telemedicine Society of India, Telemedicon 08.* 14-16 November 2008. ISBN 978-81-907196-5-0. Chandigarh, India.

85. Agarwal R, Mishra SK. *Telemedicine in Surgery*In: *Roshan Lall Gupta's Recent Advances in Surgery.* New Delhi: JAYPEE Brothers Medical Group Publisher Pvt. Ltd; 2013:263–277.

86. http://kumbhmelaallahabad.gov.in.

87. Ayyagari A, Bhargava A, Agarwal R, et al. Use of telemedicine in evading cholera outbreak in Mahakumbh Mela, Prayag, UP, India: an encouraging experience. *Telemed J E Health.* 2003;9(1):89–94.

88. Mishra SK, Ayyagari A, Bhandari M, et al. Telemedicine application in Maha Kumbhmela (Indian festival) with large congregation. *Telemed J E Health.* 2004;10:S107–S108.

89. Mishra SK. *E Health- India Case Report.; Making Better Access to Healthcare Services.* Geneva: International Telecommunication Union; 2005:164–180. ISBN 4-87739-120-7.

90. Mishra SK. Telemedicine: experience at a tertiary care hospital. In: *Healthcom 2005.* Korea: IEEE; June 23-25, 2005:6. ISBN: 0-7803-8940-9 ©2005.

91. Kapoor L, Basnet R, Chand RD, et al. Analysis of telemedicine project deployed in sub-himalayan region in the Indian state of Uttaranchal. *J eHealth Technol Appl.* June 2007;5(2):169–173.

92. Kapoor L, Basnet R, Chand RD, et al. An audit of problems in implementation of telemedicine programme. In: *Proceeding: 9th International Conference on e-Health Networking, Application & Services, Healthcom 2007.* Taipei, Taiwan: IEEE; 19th–22nd June 2007:87–89. ISBN: 1-4244-0942-X © 2007.

93. Mishra SK, Gupta D, Kaur J. Telemedicine in India: initiatives and vision. In: *Proceeding: 9th International Conference on e-Health Networking, Application & Services, Healthcom 2007.* Taipei, Taiwan: IEEE; 19th–22nd June 2007:81–83. ISBN: 1-4244-0942-X © 2007.

94. Kapoor L, Chand RD, Singh IP, et al. *Telemedicine in Developing World: Experience at SGPGIMS, Lucknow - a Tertiary Care Academic Medical Center*In: *Telemedicine Concepts & Applications.* 2008:151–160. ISBN 978-81-314-2089-8.

95. Mishra SK. e-Health India country report. *J eHealth Technol Appl.* July 2008;6(1):55–60.

96. Kapoor L, Indra PS, Repu DC, et al. Lesson learnt from the telemedicine pilot project implementation in the state of Uttarakhand. In: *Proceeding: 4th National Conference of Telemedicine Society of India, Telemedicon 08.* 14–16 November 2008. ISBN 978-81-907196-5-0. Chandigarh, India.

97. Mishra SK, Kapoor L, Indra PS, et al. National & international initiatives of SGPGI telemedicine program. In: *Proceeding: 4th National Conference of Telemedicine Society of India, Telemedicon 08.* 14–16 November 2008. ISBN 978-81-907196-5-0. Chandigarh, India.

98. Mishra SK, Kapoor L, Indra PS. Telemedicine in India: current scenario and the future. *J Telemed eHealth*. August 2009;15(6):568—575.

99. Ganapathy K. Telehealth: the reinvention of healthcare. *HOSMAC Pulse*. April 2011;1(5):9—11.

100. Ganapathy K. Tele-Health is being viewed as a distinct service, as a subspecialty. *eHealth*. April 2011;6(04):48—49.

101. Mishra SK, Ganapathy K, Bedi BS. *The Current Status of eHealth Initiatives in India*. http://ehealth-connection.org/files/conf-materials/Current%20Status%20of%20eHealth%20Initiatives%20in%20India_0.pdf.

102. Ganapathy K. *The rise of internet use and telehealth in India*. http://blogs.bmj.com/bmj/2013/11/29/k-ganapathy-the-rise-of-internet-use-and-telehealth-in-india/.

103. GanapathyK. *A virtual rural healthcare service the answer for India?*. http://blogs.bmj.com/bmj/2014/03/13/krishnan-ganapathy-is-a-virtual-rural-healthcare-service-the-answer-for-india/?g=widget_default.

104. http://www.telemedicineindia.com/telecamp.html.

105. http://www.telemedicineindia.com/media/Ajmer/ajmer-camp-01-TheHindu-Delhi-27022012.html.

106. http://www.indiamedicaltimes.com/2014/01/03/guest-article-can-ict-make-a-difference-in-providing-healthcare-by-dr-k-ganapathy/.

107. www.rockefellerfoundation.org/…/f3235b45-704f-412e-8ba6-20d92c82…;

108. http://ehealth-connection.org/files/conf-materials/mHealth_A%20potential%20tool%20in%20India_0.pdf.

109. Key Note Address. mHealth: the reinvention of health care: a perspective from India. In: *World Congress of GSMA. Barcelona, Spain*; Feb 14th to 17th 2011. http://www.mobilehealthlive.org/videos/opportunities-and-challenges-for-mobile-health-in-india/1330/.

110. Key address: Video Conferencing: 'm-health'. In *Smart Hospitals Track at IIHMR Conference on GREEN-SAFE-SMART (GSS) Practices in Healthcare on* 16th July 2011. http://www.gsshealth2011.net/key_speakers.html.

111. *The UN Foundation and Vodafone Foundation Technology Partnership*. mHealth Alliance; 2011:59. www.unfoundation.org/tech4dev.

112. Ganapathy K. mHealth poised for growth in India. *Asian Hosp Healthc Manag*. 2011;23:31.

113. M2M in Health care: An India centric overview Jan 24th—25thJanuary 2012 Berlin, Germany, http://www.enterprise-m2m.com/s1230.

114. CSIR sponsored National workshop 17th Sep 2012, Chennai Mobile Application Development for mHealth Inaugural Address http://www.drmgrdu.ac.in/Events/Pre/CSE/Sept12/MobileApp.htm.

115. *Ganapathy K. Dr. Interview : Evaluating mHealth Adoption Barriers: Politics and Economics. A Better Insight to mHealth Adoption the Three Pillars of MHealth Policy*. May 2012:10—13. with mhealth.vodaphone.com.

116. Mishra SK, Daman R, Indra PS. Innovative low cost mHealth tool kit. In: *Proceeding of The First International Conference on Intelligent Infrastructure. CSI — 2012: 47th Annual National Convention of CSI*. Kolkata: Tata McGraw Hill; 1st—2nd December 2012. ISBN 978-1-25-906170-7.

117. Ganapathy K. *Conference Organised by GSMA, Invited Guest Lecture in Session on Innovating for Health*; 22 October 2013. http://www.mobile360series.com/middle-east/Dubai.

118. Invited faculty. mLearning: the future is now. In: *National Workshop for Sensitization & Awareness on National Medical College Network Project Ministry of Health & Family Welfare, Govt. of India*. Lucknow: School of Telemedicine & Biomedical Informatics, SGPGIMS; 21-22 MARCH 2013. http://www.nrct.in/nmcnworkshop.php.

119. Mishra SK, Daman R, Indra PS. Emerging m/e-Health Applications using Low Cost mHealth Platform. In: *Proceeding of International Conference on Engineering for Humanity. (ICEH-2013)*. New Delhi: Excel India Publishers; 16th—18th August 2013. ISBN 978-93-82880-53-0.

120. Arun Rai, Ganapathy K, Liwei Chen K et al. *Will m-Health be accepted in India? Results of a Pan India Health Survey* http://www.transformhealth-it.org/2nd%20Day%20(07-Sep)%20-%20THCIT%202013%20Program%20Schedule.pdf.

121. Indra PS, Kapoor L, Indra PS, et al. Comparative study of connectivity in telemedicine. *J Telemed eHealth*. October 2008;14(8):846—850.

122. Mahapatra AK, Kapoor L, Indra PS, et al. Capacity building in e-Health in a developing country — Indian initiatives. *J eHealth Technol Appl*. July 2008;6(1):61—62.

123. Indra PS, Daman CR, Mishra SK. Comparative technical evaluation of various communication media used for tele-medical videoconference. In: *Proceeding: 10th IEEE International Conference on e-Health Networking, Applications & Services, Healthcom 2008*. Singapore: Biopolis; 7th—9th July 2008:3. ISBN 978-1-4244-2281-4. © 2008 IEEE.

124. Kapoor L, Daman CR, Indra PS, et al. E-Learning technology in healthcare — indian case study. In: *Proceeding: 10th IEEE International Conference on e-Health Networking, Applications & Services, Healthcom 2008*. Singapore: Biopolis; 7th—9th July 2008. ISBN 978-1-4244-2281-4. © 2008 IEEE.

125. Vijay PS, Kapoor L, Daman CR, et al. Development and maintenance of e - seminar web Portal on national knowledge base on telemedicine & e Health — an audit of one year activity. In: *Proceeding: 4th National Conference of Telemedicine Society of India, Telemedicon 08*. 14—16 November 2008. ISBN 978-81-907196-5-0. Chandigarh, India.

126. Daman CR, Indra PS, Kapoor L, et al. Design of IP based intra-operative tele-consultation module. In: *Proceeding: 4th National Conference of Telemedicine Society of India, Telemedicon 08*. 4—16 November 2008. ISBN 978-81-907196-5-0. Chandigarh, India.

127. Manoj J, Rashmi J, Prasad KK, et al. Usefulness of optimization of digital images in telepathology practice. In: *Proceeding: 4th National Conference of Telemedicine Society of India, Telemedicon 08*. 4—16 November 2008. ISBN 978-81-907196-5-0. Chandigarh, India.

128. Daman CR, Mishra SK. Critical evaluation of software based videoconference solution for telemedicine. In: *Proceeding: 3rd International Conference on Health GIS 2009: Health GIS Enabling Health Geospatially*. 24th—26th July 2009. ISBN 978-974-300-596-1. Hyderabad, India.

129. Daman CR, Mishra SK. Telemedicine technology medical equipment & automation: India's premier magazine diagnostic, medical equipment technology. Jan—Feb 2010;3(2):32—42.

130. Mishra SK, Daman CR, Indra PS. Current status of telemedicine network in India and future perspective. In: *Proceedings of the 32nd Asia-Pacific Advanced Network Meeting*. 2011. http://dx.doi.org/10.7125/APAN.32.19.

131. Daman CR, Mishra SK. Critical evaluation of software based videoconferencing solution for telemedicine. *Int J Geo-Inform*. June 2011;7(2).

132. www.mit.gov.in/telemedicine/home.

133. http://nmcn.in/workshopeast/pdf/session3/Shri_BS_Bedi.pdf.

134. Mahapatra AK, Kapoor L, Kumar S. Telemedicine technology in cancer care — developing country perspective. In: *Proceeding: 10th IEEE International Conference on e-Health Networking, Applications & Services, Healthcom 2008*. Singapore: Biopolis; 7th—9th July 2008. ISBN 978-1-4244-2281-4. © 2008 IEEE.