Healthcare
Information Technology

The Indian Scenario

Editor
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Published on behalf of NDRF by

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Message from Dr. Prathap Reddy, Founder Chairman, Apollo Hospitals Group

It is wonderful that on the behest of the National Design and Research Forum. Apollo Hospitals is compiling a monograph on Information Technology in healthcare. IT has now gained an all-pervasive role in healthcare delivery be it in a primary or territory care environment or for preventive. Diagnostic or curative care being delivered to the remotest rural areas or an urban hospital.

Moreover with the advances. Information Technology now has the power to make healthcare accessible and available 24/7 also bridge the urban-rural health divide. IT has led to the evolution of contemporary models of e-Health which broadly encompasses mHealth, telemedicine and telehealth. Which are becoming integral to Digital India.

It is rather unfortunate that despite all this progress. India today faces an insidious threat which is that of Non-Communicable Disease also a major threat for the developing and under developed world. According to the World Economic Forum. By 2030 The world could looses 30 trillion dollars about 36 million people will die every year due to NCDs if remedial action is not taken quickly. Therefore the significant power of Information Technology must be harnessed to make a big impact in bringing awareness to people across rural and urban geographies about the risk factors of these diseases. IT could also aid immensely in early diagnosis and care.

It is heartening that thus publication is the result of contributions from pioneers and authorities who are actually practicing what they preach and diversity ensure that the book would give an over view and excellent source of information both to those in the health care industry and also those in the IT industry. I once again congratulate all the contributors and hope that there will be many publications reflecting the exponential growth of IT in healthcare.

Dr. Prathap Reddy
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Message

Healthcare for all Citizens is an important aim for any mature country. For India, this challenge demands relevant technologies and innovative management. India produces a large number of Doctors and healthcare professionals but not in sufficient numbers and with desired quality. India is also a leader in IT related services in the World. Leveraging India's IT prowess in the Healthcare sector along with synergy of technology and skill sets can enable reaching adequate services to all her citizens across length and breadth of our vast Nation.

The Monograph on "Health Care Information Technology" authored by Dr.K. Ganapathy, President, Apollo Telemedicine Networking Foundation and many distinguished co-authors is a synthesis of a wealth of expertise and experiences. I believe that this book will be a guide and inspiration to those interested in this fascinating topic and who are willing to participate in this nationally important mission of "Healthcare for All".

This is yet another publication in line with NDRF's endeavour to publish books of high National impact. This book is brought out with support from The Institution of Engineers (India) and WFEO (World Federation of Engineering Organizations) to whom we are indebted.

I congratulate Dr. K. Ganapathy and other co-others along with the NDRF team for achieving publication of the Monograph.

The feedbacks and suggestions shall be of value, when we publish 2nd Edition of this book or take a decision to publish the monograph in Indian languages.

B. Idev Raj

Dr. Baldev Raj
Chairman, NDRF

27 March 2017

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I am delighted to learn that the National Design and Research Forum and the World Federation of Engineering Organizations are jointly bringing out a monograph on the deployment of **Information Technology in Healthcare.** Telemedicine Society of India is pleased to be a co sponsor and help these organisations create the much needed awareness in spreading the importance of deploying Information Technology in Healthcare. We are also pleased that Prof.K.Ganapathy a Past President of the Telemedicine Society of India and a telehealth evangelist *par excellence* was entrusted with this daunting task. This compendium covers a variety of topics and would be of interest to a diverse audience from both the healthcare sector and from the IT industry. The contributors are authorities in their respective fields. The TSI will use this publication to help achieve its primary goal – to ensure that the use of IT in Healthcare – is integrated into the core of the health care delivery system. The very fact that the Chairman of ISRO Padma Sri A. S. Kiran Kumar and the principal architect of modern health care Padma Vibushan Dr Pratap C. Reddy have endorsed this publication speaks for itself. I once again congratulate all the contributors and the organisations in bringing out this much needed monograph.

Prof. K. SELVAKUMAR

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29th March 2017

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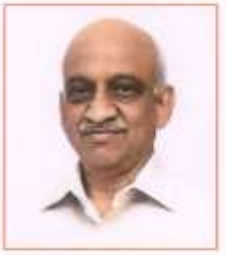

MESSAGE

I am pleased to learn that the National Design and Research Forum, the World Federation of Engineering Organizations and the Telemedicine Society of India are jointly bringing out a monograph on the deployment of Information Technology in Healthcare.

The phenomenal developments in the areas of information and communication technologies have transformed the service delivery mechanism and the philosophy. From inception, ISRO has been making pioneering efforts in leveraging the benefits of space technology to address the problems of common man. The Tele-medicine Programme of ISRO, initiated during 2001, by connecting hospitals located at isolated far flung areas to tertiary care hospitals in metro cities, demonstrated a new possibility for better healthcare delivery to the people who otherwise had no access to it. The advances in information and communication technologies in health care and their synergistic effects brought in allied concepts of Tele-health, e-Health, Digital Health etc. into being. The convergence of multiple technologies enabling seamless information flow holds much more potential for the future.

The contributors in this monograph have vetted their hands in Tele-medicine with active involvement in shaping and driving it with great enthusiasm. It covers a variety of topics and would be of interest to diverse audience from both the healthcare sector and from the IT industry, particularly the budding professionals. All transitions offer great opportunities. We need to be future-ready accepting the challenges to be ahead of schedule, in adopting technologies for improving the quality of life.

I congratulate the contributors and publishers for bringing out this much needed compendium and wish it serves the purpose in making the technology take the quality healthcare to the doorsteps of the common man.

आ सी किरण कुमार
(आ. सी. किरण कुमार)
(A. S. Kiran Kumar)

Bangalore
March 28, 2017

Preface

The World Federation of Engineering Organizations had requested the National Design and Research Forum, India to bring out four Monographs related to ICT, of relevance to India and the world. The WFEO Committee on Engineering for Information & Communication (WFEO-CIC), presently hosted by The Institutions of Engineers India, has set its objectives in the area of technological evolutions, with a view to identify suitable technologies for sustainable development, especially in the context of the UN Millennium Development Goals. Creating awareness on "ICT for Development" is the main goal of WFEO-CIC with a focus on developing countries, where bridging the gap is crucial. Providing authenticated validated information in the rapidly emerging area of **Health Care Information Technology** through a specialized monograph, to all stakeholders, particularly in the context of emerging economies, will help fulfill this objective.

A solution is not a solution unless it is available to everyone, anytime and anywhere. The Health Industry is the only recession proof entity .Deploying Information Technology is the only way in which quality, affordable, equitable health care can be provided universally. "Health is wealth" is not just a cliché. Health has long been proven to be a key driver, in the economic prosperity of nations. Society needs to be kept informed of technological advancements and new findings that come into existence in various sectors, to ensure their adoption and effective usage.

This book is unique in that the diversified groups of contributors are all from the industry, deploying every day, what they have written about. None are hard core arm chair theoreticians. The 12 topics encompassing 177 pages of current information also have additional references

I am thankful to Dr Ramachandra, Director National Design and Research Forum, Bengaluru for inviting me to bring out this monograph. I am thankful to all the contributors for submitting the articles. I am thankful to Dr. Prathap Reddy Founder Chairman Apollo Hospital Group, Sri Kiran Kumar, Chairman ISRO and Prof. K. Selvakumar President, Telemedicine Society of India for their encouraging messages.

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President, Apollo Telemedicine Networking Foundation
Past President, Telemedicine Society of India
Former Secretary and Past President Neurological Society of India
Emeritus Professor The Tamilnadu Dr MGR Medical University

Table of Contents

List of Contributors

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PROF. S. V. RAGHAVAN, Chief Architect and Chairman, Technical Advisory Committee, India's National Knowledge Network (NKN).Advisor & Counsel to Ministry of Communications and Information Technology and Ministry of Human Resource Development (in-charge of higher-education in India) Served as Scientific Secretary to Government of India in the Office of the Principal Scientific Advisor .Founder member of ERNET in the 1980s (Education & Research Network, a contemporary of DARPA, United States) and served as Director of Network Systems Laboratory (NSL) for over three decades.

DR SUPTENDRA NATH SARBADHIKARI is the Project Director, Centre for Health Informatics, National Health Portal, Ministry of Health and Family Welfare, Government of India .A physician and a health informatics educationist he is a pioneer in spreading awareness of health informatics in India. He is a member of the e-Learning Advisory Group (ELAG) of SNOMED-CT, the Committee for Implementation of Standards for Electronic Health Records and member of Project Review and Steering Committee for the Indian NRC of SNOMED-CT,He is a Former Chairman [2013-2015] for Health Level Seven (HL7) India and Former Vice President of the Indian Association for Medical Informatics [2013-2015].

ARVIND SIVARAMAKRISHNAN is the CIO of Apollo Hospitals Enterprise Ltd, India responsible for IT strategy and implementation across the Apollo Hospitals group. Arvind has extensive experience in management consulting, architecting, and building solutions for enterprise wide applications. Under his leadership Apollo Hospitals obtained the HIMSS Level 6 Health care IT maturity model (only 7.3% of 8,600 hospitals worldwide have achieved this) and the HiMSS- Elsevier award for outstanding use of IT in patient care delivery in Asia Pacific. Earlier he was Director of Clinical Applications with Henry Ford Health system @ Michigan USA. . He is a certified project management professional from the PMI, USA and Six Sigma Black belt from ASQ, USA.

DR.SUMANTH C RAMAN is a Specialist in Internal Medicine who works in the field of Healthcare IT as a domain Consultant with one of the world's leading Software Services Organizations. Over the last 2 decades he has been actively involved in the development of Healthcare applications like Hospital Management systems, Electronic Medical Records, Telemedicine systems, Clinical Decision Support systems, E-Health and Patient monitoring tools etc. He has led some of the largest successful implementation of such systems across India and abroad in both the Government and the Private sector. He is also a well known Television anchor and a reputed quiz master

U K ANANTHA PADMANABHAN Group Advisor MGM Healthcare Group, Chennai has had a long standing career in hospital management, Ananth is responsible for leading the Arcus HIS global product road map and for managing the Professional Services team. Healthcare domain knowledge, deep insights into various health ICT applications particularly Cloud-hosted delivery models has been his forte. Amongst others, Ananth held leadership positions in Rainbow Hospital and Apollo Hospitals during the latter's inception.

MURTHY REMILLA, Deputy Project Director (DPD), at ISRO Satellite Centre (ISAC), Bangalore. An energetic and enterprising individual with a diverse career graph spanning 25 years of rich cross functional experience covering the technical, business and managerial domains. Associated with ISRO Telemedicine Programme since 2001, he is an active member of the Telemedicine Society of India. He has been on the Editorial Board of 'Telemedicine and eHealth' journal of American Telemedicine Association (ATA). Has 40+ publications in Remote Sensing, Telemedicine and Societal applications of Space Technologies.

BAGMISIKHA PUHAN is a practicing Advocate, focusing on Technology Law and Intellectual Property Rights, Space Technology and Health IT. She graduated from KIIT University in 2014 with a BA.LL.B. (IP Hons.). Currently, she is working with TMT Law Practice & in Health IT vertical, in an advisory and consulting role. As a member of the Telemedicine Society of India, and other non-profit organizations in health and medicine, she researches and works on the regulatory and policy aspects of telemedicine practice and other areas of health and medicine.

DR. RANA MEHTA has more than 19 years' of experience in strategizing, planning, commissioning and operations of over 50 hospitals and healthcare systems in Asia. He is conversant with the excellence of services expected in the present competitive scenario across the entire healthcare value chain. He has worked on numerous assignments to develop customized healthcare solutions to suit client needs within political, socio economic, geographic, and demographic imperatives. He played a major role in commissioning and operating Apollo Hospitals in New Delhi and Colombo. He has also been advising clients in mobile and remote healthcare space, to implement transformation of healthcare in a rapidly changing, information-intensive environment.

SAYANTAN CHATTERJEE is an Associate Director in Healthcare practice in PwC India and is leading the Healthcare Technology team. He has 12 years of experience in Healthcare Technology consulting for both Healthcare providers and payers, in India, Singapore, Hongkong, Malaysia, UK and Australia. He has helped clients use technology as a business lever and in defining their Business Technology strategy thus helping in execution with respect to designing and implementing technology applications and initiatives. His key skills include Digital Hospital Strategy and IT systems implementation/project management. He had worked with KPMG (India and UK) and IBM, India in their Management Consulting team focusing on Technology strategy and Healthcare.

Table of Contents

List of Figures

List of Tables

1 Healthcare Information Technology: An Overview

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1.1 Introduction

Healthcare is one of the most essential services in any society. The Indian healthcare services is one of the biggest services in the world, with every sixth individual on the planet, being a participant. According to a FICCI-KPMG report India's healthcare sector is expected to be $280 billion in size by 2020, growing at a compound annual growth rate of 16%. India is expected to rank amongst the top three healthcare markets by 2020, from the sixth largest market globally, in terms of size, in 2014.The telemedicine market in India was valued at USD 7.5 million, and is expected to rise at a CAGR of 20 per cent, to USD18.7 million by 2017. India is also becoming the healthcare destination for many countries worldwide. In October 2015, India's medical tourism sector alone was estimated to be worth US$3 billion. It is projected to grow to $7–8 billion by 2020. At least 200,000 patients come every year to India for health care, based on excellent outcomes, with no waiting time and at a far reduced price

The Indian IT *sector* is also a major global player. According to NASSCOM, the sector aggregated revenues of US$147 billion in 2015, where export revenue stood at US$99 billion and domestic at US$48 billion, growing by over 13%. India is now one of the biggest IT capitals of the modern world and all the major players in the world IT sector are present here. The Indian IT market currently focuses on providing low cost solution in the services business of global IT**.** Information Technology in India is an industry consisting of two major components: IT services and business process outsourcing (BPO). The sector has increased its contribution to India's GDP from 1.2% in 1998 to 7.5% in 2012.

The Indian healthcare IT market is valued at $1billion (about Rs 6,650 crore) and is likely to grow 1.5 times by 2020, according to NASSCOM. According to Frost & Sullivan the HCIT market in India is expected to reach $1,454.7 million in 2018 from the present $381.3 million, mainly due to fast adoption of technology by stake-holders. The healthcare software segment generated revenues of $96.8 million in 2014 and is likely to grow at a CAGR of 11% over the next five years. Comparatively, the worldwide health tech market is estimated to grow at a CAGR of 6% to $25 billion by 2020 from $17.36 billion in 2014. In India, healthcare software is a small part of the total healthcare IT segment, comprising only about 9%. There are about 150 companies operating in this space in India and they are creating products and solutions for a global customer acceptance,

It is only recently, that these two globally recognized mega services (Healthcare and ***IT***) have realised, how much they can help each other. Traditionally health care systems have allotted only 2 - 2.5% of their budget, towards IT expenditure as contrasted to 5 to 6% in the banking industry. Although the health care sector is growing at 1.5 times the GDP growth rate, IT investments in health care in India to date, have been insufficient though it has been

unequivocally demonstrated that IT has the potential to improve the quality, safety, and efficiency of health care.

1.2 Background

Information technology (IT) has the potential to improve quality, safety, and efficiency of health care. Diffusion of IT in health care is generally low (varying, with the application and setting). Drivers of investment in IT include promise of quality and efficiency gains. Barriers include cost and complexity of IT implementation, which often necessitates significant work process and cultural changes. Certain characteristics of the health care market including payment policies that reward volume rather than quality and a fragmented delivery system, also act as deterrents. At INR 690 billion, private expenditure accounts for a significant proportion of the Indian health care delivery market. The real-time data provided by web-enabled technologies, helps to strengthen monitoring, enabling policy makers to take better informed decisions on public health delivery. Several multinational companies such as GE Healthcare, Intel, Hewlett Packard, Cisco Systems, Qualcomm, Microsoft, Google, IBM, Computer Sciences Corporation (CSC), Perot Systems, TCS and HCL have entered the health IT space. India has the fastest-growing health care IT market in Asia, with an expected growth rate of 25%, followed closely by China and Vietnam. IT is specifically used for computerization of medical records, networking various departments in the hospital, and providing telehealth services.

The private and public sectors have engaged in several efforts to promote the use of HCIT within and across health care settings. Delivering quality health care, requires providers and patients to integrate complex information from many different sources. Increasing ability of physicians, nurses, clinical technicians, and others to readily access and use the right information, at the right time and right place about their patients should significantly improve quality of care. The ability for patients to obtain information to better manage their condition and to communicate with the health system will contribute to a win-win situation. Through information power that IT enables, capacities of decision-makers are continually transformed, in how they link with each other, in the here and now. This could also raise fears and anxieties, as the pervasive nature of IT and its uneven diffusion, increases vulnerability necessitating policy safeguards.

1.3 An Optimistic Outlook

Information technology is one of the most dynamic and high-impact components of healthcare delivery. It has the ability to revolutionize healthcare. In spite of delayed adoption of *IT*, healthcare in India is now on the threshold of transforming itself into an IT driven entity. The current healthcare ecosystem has several challenges to overcome, before the healthcare revolution is realised. From its historical focus on acute care i.e. dealing with immediate and severe outbreaks of illness, healthcare is now concentrating on chronic, continuous care for long term illnesses. Preventive care, focusing on early detection will eventually lead to predictive care, focusing on changes in lifestyle, and behavioural modification. This new application is in turn changing IT requirements of hospitals.

The emergence of corporate hospitals has resulted in modern professional hospital management. Most hospitals of yester years organise their resources and manpower within structures that had evolved, rather than create newly designed systems. Till recently, modern

management systems had not penetrated most healthcare institutions. Information capture would be rudimentary and information rarely integrated, beyond that required for reporting purposes. Data-based quality control would thus not be possible.

1.4 Spectrum of HCIT

- A complete **Healthcare Information Management System** (**HIMS**) which involves implementation of a clinical system for managing electronic patient records (EPR) and development of clinical care pathways is the need of the hour. This clinical system needs to be integrated seamlessly with the hospital administration system. Thus complete demographic information of the patient i.e. age, name, sex, patient's present illness, history, medication, consultant notes, etc. will be available. This separates point of care and diagnostic resources, enabling healthcare providers to extend their reach to geographies, where such resources are not available to patients.
- The Government of India has launched the Health Management Information System (**HMIS)** portal to convert local health data into real time useful information, management indicators and trends which could be displayed graphically in reports
- Hospital Information Systems (**HIS**) is an element of health informatics that focuses mainly on the administrational needs of hospitals. In many implementations, a HIS is a comprehensive, integrated information system designed to manage all the aspects of a hospital's operation, such as medical, administrative, financial, and legal issues and the corresponding processing of services.
- Picture archiving and communication system (**PACS)** is a medical imaging technology which provides economical storage and convenient access to images from multiple modalities.
- An electronic medical record (EMR) is the systematized collection of patient and population information, electronically-stored health information in a digital format. These records can be shared across different health care settings through network connected, enterprise wide information systems or other information networks and exchanges. EHRs include demographics, medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, personal statistics like age and weight and billing information.
- Clinical decision support systems (**CDSS**) are health information technology systems that are designed to provide clinicians and other health professionals assistance in clinical decision making. They link health observations with health knowledge to influence health choices by clinicians for improved health care, using artificial intelligence.
- Computerized provider order entry (**CPOE)** is a process of electronic entry of medical practitioner's instructions, for the treatment of hospitalized patients under his or her care. The entered orders are communicated over a computer network to the medical staff or to the departments (pharmacy, laboratory, or radiology) responsible for fulfilling the order. CPOE decreases delay in order distribution, resource allocation, order completion and reduces errors related to handwriting or transcription ,allows order entry at the point of care or off-site and provides error checking for duplicate or incorrect doses or tests. It is a form of patient management software.
- **Barcode** technology in healthcare is the use of optical machine-readable representation of data in a hospital or healthcare setting. It is similar to bar-code scanning in other environments: An optical scanner is used to electronically capture

information encoded on a product. Initially, it will be used for medication (for example, matching drugs to patients by using bar codes on both the medications and patients' arm bracelets), but other applications may be pursued, such as medical devices, lab, and radiology.

- **Healthcare predictive analytics** uses technology and statistical methods to search through massive amounts of information, analysing it to predict outcomes for individual patients. In medicine, predictions can range from responses to medications to hospital readmission rates.
- **Cloud Computing** : A health care cloud is a cloud computing service used by health care providers for storing, maintaining and backing up personal health information (PHI). It is capable of storing significantly more data than an on-site physical serrver, particularly large image files. In addition, health care cloud storage costs are a fraction of those for on-site servers; however, the transition requires a full-fledged server virtualization implementation. Many physicians and health care organizations are reluctant to use health care cloud services for fear of suffering a data breach
- **eEducation:** When ICT is applied to health education, it is possible to make high quality education available pan India seamlessly. Virtual skills laboratories where a large number of medical and surgical procedures are simulated on virtual patients are now a reality in advanced countries. We need to have such learning centres. To achieve all this, IT should be a part of the medical curriculum. Similarly, Applications of IT in Healthcare should be taught to all IT students.
- **Health Research**: ICT can potentially transform the medical scene in India, by bringing about a sea change in medical research. From traditional clinical research to the modern biology-based research, the opportunity is immense. Work on problems such as Cancer prevention, screening, diagnosis and therapy can benefit from inter disciplinary cooperation. Considerable computation power and hi speed broad band connectivity is required for this.
- **Telehealth** is a major deployment of HCIT. Patients can be examined, investigated and managed remotely with the clinician elsewhere physically. HCIT has made distance meaningless. In fact Geography has become History
- **mHealth** With the exponential increase in mobile telephony and the eventual deployment of **4**G, it is imperative that broad band wireless technology be exploited and used to develop mHealth. mBanking, mCommerce and mEntertainment have already shown the way .
- **Snowmed CT:** SNOMED CT is the most comprehensive clinical healthcare terminology in the world. The Systematized Nomenclature of Medicine (SNOMED) is a systematic, computer-processable collection of medical terms, in human and veterinary medicine, to provide codes, terms, synonyms and definitions which cover anatomy, diseases, findings, procedures, microorganisms, substances, etc. It allows a consistent way to index, store, retrieve, and aggregate medical data across specialties and sites of care. National Release Centre India manages the use of SNOMED Clinical Terms (SNOMED CT) and communicates with a range of stakeholders, including SNOMED CT Affiliate Licensees, healthcare institutions, clinical groups and end users. The Ministry of Health and Family Welfare (MoH&FW) has designated Centre for Development of Advanced Computing (C-DAC), Pune to run

the National Release Centre (NRC) for distribution and management of SNOMED CT within India

- **Remote Installation services** (RIS), is a Microsoft-supplied server that allows certain types of computers to remotely execute boot environment variables. Installation images of operating systems or computer configurations are created , which is used to demonstrate the installation process to users whose machines have been granted access to the RIS server.

Advantages of Enabling IT in Hospitals

1. Quality of service improves increasing reach and delivery of service.
2. Integrated EMR's facilitate research, as data is made available in structured manner, which helps in studying trends, identifying disease outbreaks etc.
3. Enables Customer Relationship Management (CRM
4. IT helps patients and their records move seamlessly across different geographical locations.
5. IT provides flexibility in procuring and billing.
6. IT also provides accounting framework, hence helps with entire billing, inventory management, store management, laboratory management, etc.
7. In IT enabled hospitals, the bed turnaround ratio has increased by 10%, justifying investment towards enabling IT.
8. India has the advantage of a strong IT fibre backbone and indigenous satellite communication technology with trained human resources.
9. Makes hospitals filmless and considerably reduces paper work, faster patient throughput, faster diagnosis, reduced manpower requirement and captures patient history at one place.
10. Faster more efficient pre hospital authorisation from insurance companies.
11. Reliable, real time Big Data will enable health Insurance companies to more scientifically do India centric actuarial studies and compute premium values. This will ultimately benefit the public.

1.5 Challenges in implementing Healthcare Information Technology (HCIT)

- IT in healthcare had not taken off in India despite a strong healthcare market. Lack of regulations, standardization and reduced professionalism have contributed to this. Certification, authentication, registration, adoption of minimum safe standards, expanded efforts to standardize record formats, nomenclature, and communication protocols to enhance interoperability are essential.
- Major urban rural health divide with lop sided distribution of specialists. This leads to " poverty amidst plenty" and under-utilization of capacity (beds, doctors, nurses)
- Fragmentation of isolated bits of patient and medical know-how across entities in the ecosystem. High Cost / Low Productivity due to bottom-up re-creation of diagnosis/analysis for every patient, in the absence of a universally accessible record.
- Business models currently focus on acute care. It is necessary to look at preventive and chronic care with alternative delivery and transaction models to multiply reach.
- Integrated health records - A complete, updated / accurate one point patient database is not available - an integrated electronic medical record system (EMR) - This helps

in capturing of information and maintaining continuity and granularity. Lack of a one-point, complete patient record

- Indian healthcare system is heterogeneous, diversified with considerable variations in demography, literacy, socio-economic profile and availability and access to health care.
- Necessity for financial incentives and disincentives as practiced in the USA with increased investments
- Acceptance of this modality by family physicians specialists, patients, administrators, government and society.
- Designing cost effective, appropriate, need based user friendly technology
- Ensuring reliable connectivity, hardware and software
- Running short term courses and subsequently refresher courses to train the trainers and the users. Introducing HCIT in the medical/ IT curriculum.
- Enforcing regulations on HCIT and passing a HCIT Act for India.
- Getting grants, subsidies and waivers as necessary to introduce HCIT in suburban and rural areas.
- Lack of in-house IT expertise, reluctance of medical, nursing and other staff to change, fear of technology failing (paper systems appear more reliable).
- Poor support from vendors, reluctance of vendor to make changes in software when requested particularly customization of software used to computerize manual processes without proper refinement in policies and procedures; lack of proper implementation methodologies (detailed process study and refinement strategy) ; to make the management aware about time and efforts required for successful computerization and not using standard inter operable, scalable software.

1.6 The Speed Breakers

At present, India lacks comprehensive regulations in the healthcare space. The private and public medical sectors need to be made more accountable for executing basic standards of care. There are no acts similar to the Health Insurance Portability and Accountability Act (HIPAA) which was passed in 1996, in the United States. HIPAA requires unique identifiers for providers, health plans, payers and patients in order to increase the speed of payments, reduce costs, and promote coordination among healthcare entities. Empowered agencies need to periodically inspect and rate hospitals according to facilities, infrastructure, and technical manpower available. With this provision, the quality of service at various levels of healthcare delivery is likely to be benchmarked. JCI and NABH (Joint Commission International and National Accreditation Board for Hospitals) are playing a significant role in furthering the deployment of HCIT. General practitioners and small nursing homes, the first point of contact for most people need to be convinced that using HCIT is in their interest. This will take a long, long time.

1.7 The Accelerators

Future ready regulations in the healthcare space, emergence of hospital networks, expansion of hospitals, corporatization of providers, growth of health insurance participants, and the need for sharing of data between various healthcare participants are proving to be the key drivers of IT adoption in Indian healthcare. The presence of comprehensive regulations is resulting in the de-integration of the healthcare industry into various participants – providers, payers,

pharmaceutical companies etc. These participants have a clearly defined role and accountability to their customers. This results in the emergence of multiple service providers, driving competition. Providers now recognize the need for higher IT spending, in order to reduce expenses, improve productivity, and achieve patient satisfaction. Regulations and Government initiatives act as a major catalyst in propelling the healthcare industry toward the much-needed standardization. Encouraging private participation in the health insurance sector and privatization of primary and secondary healthcare services in a few states, have already accelerated the growth of Indian healthcare and consequently adoption of HCIT. Increasing outsourcing of various healthcare functions like teleradiology, ePHC , medical call centres etc by state governments in a PPP (Public Private Partnership) mode is leading to increased responsibility, accountability and transparency . This and necessity for real time dashboards mandates use of sophisticated HCIT. This is leading to vertical integration of primary, secondary, and tertiary care hospitals, developing hub-and-spoke models, and the development of networks of diagnostic centers across the country by private participants. As 140 million upper and middle class people, growing at 4% per annum with combined annual income of over Rs 8200 billion. can spend more than the per capita national average of Rs. 600, the potential for growth in the health services sector is immense. This group alone, willing to pay for quality services can .justify investment in HCIT by private hospitals.

The Indian healthcare landscape is changing and IT is poised to revolutionize healthcare. There is a change in the mindset of all stakeholders. The original perception was that IT only automates medical processes. A definite increase in return on investments (ROI) is now being accepted. With increasing availability of health insurance and changing regulatory framework, healthcare providers today see value in the adoption of IT. Corporate hospitals and National institutes like AIIMS are pioneering this change.

Making NABH accreditation mandatory for empanelment with major organisations has gone a long way in promoting HCIT. NABH a constituent board of the Quality Council of India, was set up to establish and operate accreditation and allied programs for healthcare organizations.. Its main objectives are accreditation of healthcare facilities, quality promotion including nursing excellence, patient safety and laboratory certification. The high standards, necessity for external audit and re audit make deployment of IT a necessity. Deployment of IT at the tertiary level dominated by large corporates and private participants is very promising

It is a matter of justifiable provide that Apollo Main Hospital Chennai as early as Q1 2013 had reached Stage 6 on its Electronic Medical Record Adoption ModelSM (EMRAMSM). At that time just 7.3% of 8,600 hospitals tracked by HIMSS Analytics. (includes HIMSS Analytics US, Europe and Asia Pacific) had achieved this. (2.4% for Asia Pacific.) . Other big hospitals in India are now getting ready for this.

1.8 The Road Ahead

Corporatization of healthcare providers is contributing to a transformation in the Indian healthcare delivery system. Private participants emphasize on technology upgradation and professionalism and have realized the benefits of adopting IT. They are investing large amounts in new technologies to cut costs and improve quality of service. Private participation is also a major force in tapping the huge Indian health insurance market. This sector calls for a

higher level of technology requirement. Tracking premium payment, linking of branches, maintaining patient records and networking with hospitals requires HCIT. Changes in the regulatory framework, grading of hospitals, and government initiatives are also major catalysts.

Viewing healthcare services as an industry and attempting to achieve a sigma six though improbable is not impossible. Using HCIT should not be viewed as a dehumanising process. IT should be viewed as a tool to achieve an end, not an end by itself. IT has improved patient care in many, many ways. Providing real time appropriate relevant information to every stakeholder in the healthcare industry makes all the difference. Well informed patients and doctors can make significant differences in the standard of healthcare. Rapid increase in computing power is accompanied by exponential reduction in costs. Though the healthcare IT market in India has grown 200-300 per cent in the last 10 years, it is accepted that the healthcare sector has to be more IT-oriented. Studies indicate that the use of IT in healthcare has enormous benefits-short term and long term for all stake holders, for e.g. a patient's hospital stay could be reduced by up to 39 per cent with improved use of IT.

A major advantage that developing countries in Asia have, with regards to being ready for the rapid technological changes shaping healthcare globally, is the fact that they have no colonial legacy to 'disinherit' in the field of modern healthcare; for example, they do not have to 'unwire' to introduce mHealth. One does not have to undo to keep up with technology simply because e-Health is still not a reality. We do not have to follow the advanced countries. We do not have to piggy back or leap frog. We will pole vault!

Information plays a key role in health care Adopting a health IT system involves more than just deciding to spend money; it is a major organizational commitment that, for hospitals in particular, will probably last for several years. To take full advantage of such a system, clinicians have to substantially redesign the way they practice medicine. EHRs are only as helpful as the information that goes into them. Some of that information is part of the system when it is purchased, but much of the technology's value *comes when physicians devote considerable time to training, to personalize the system, and adapting their work processes to achieve the maximum benefits*. Not surprisingly, the adoption rates for health IT systems are higher among younger physicians, who in general are more at home with computers than their older colleagues. In implementing a health IT system, providers must choose from among a wide array of vendors and options. With so many choices (, more than 50 different EMR vendors) and rapidly developing technologies, many providers may be concerned about buying the wrong kind of system for their practice, acquiring technology that has already become outdated, or purchasing a poor-quality system. They may wish to postpone the decision until more of their colleagues have purchased systems.

Worldwide legislation can never ever keep up with changing technology. It is an erroneous perception that growth of HCIT will be hampered because legislation on this is not available. Let us not put the cart before the horse. Rome was not built in a day. Necessity is the mother of invention. Once HCIT is more widespread, more attention will be paid to legislation issues.

1.9 The Changing Landscape

Growth in data, digitization trends in health information and electronic medical records, improvements in collaborative data exchange, workflows and mobility, and need for better financial management are changing the needs of the hospital enterprise. Additionally, patient demographic changes and chronic disease growth, cost control considerations, and importance of patient safety, have all come together to heighten demand for HCIT, The increase in adoption of EMR, mHealth, telemedicine, and web-based services is making electronic patient data expand, necessitating the implementation of robust IT systems in Indian healthcare institutions. Ease of integration with existing solutions and retrofitting is a sine qua non . The main challenge during and after implementation of EMR, is the time spent by doctors and employees on EMR system proving the importance of training, retraining, learning, relearning and unlearning. HIT services will initially be deployed in metros, Tier I and Tier II cities. The management needs to do a cost versus benefit comparison, Integration of user-friendly systems access to mobile devices such as tablets, more shareable information platforms and standardisation could lead to more usability. Integrated systems will enable developers to create cloud-based solutions, making upgrades and maintenance quicker and more efficient. Shift to wireless technology, mobile devices and cloud computing will reduce system costs and improve workflows.

Enhancing the information flow at various levels will provide useful and timely inputs, for programme development and monitoring. Midcourse interventions in policies would be a direct spin-off. Several multinational companies like GE Healthcare, Intel, Hewlett Packard, Cisco Systems, Qualcomm, Microsoft, Google, IBM, Computer Sciences Corporation (CSC), Perot Systems, TCS, HCL and Tech Mahindra to name a few, have entered the health space.

These new healthcare models initiated by the IT companies, while delivering quality care will explore the possibility of innovative new technology that are simple to use, cost effective, portable and power independent. Challenges in integrating IT into the healthcare system in India can be addressed by leadership and strong message from the top, ownership by the departments and long term vision, Health Administration acting as facilitator and recognising *IT* as a felt need in health, recognising champions among the health personnel, customising *IT* solution to needs of the users, confidence building, good co-ordination and communication between vendors and users.

- Universal adoption of Personal Health Records (PHRs) and Electronic Medical Records (EMRs) is a challenging and daunting task even in the most advanced countries. The very fact that we have started talking about it in India is itself a good sign. It was Confucius who once remarked “a journey of a thousand miles begins with the first step”. The concept of Personal Health Records (PHR) gathered steam as several healthcare and insurance providers initially established connectivity with PHR platforms like Google Health and Microsoft HealthVault. Today many large corporate hospitals provide facilities to their patients for online storage and retrieval, on the cloud.
- One of the barriers in the adoption of international e-health standards in hospitals, is the priority given to internal process functionality. Standardisation of data and processes across hospitals will go a long way in enforcing the use of PHR, EMR etc.

A Hospital Information Management System (HIMS) should essentially interconnect all departments of the hospital seamlessly and attempt to minimise operations on paper. No doubt it will take a long, long time before PHRs and EMRs become a reality in India, but it will certainly happen.

- HIT strategy should be driven broadly by business, clinical and societal requirements. Business needs are around administrative work, financial and procurement. Clinical and social needs are quite specific. For example, patients need to access their health records, get reminders and be advised by doctors even when on the move. Data needs to be captured at source, whether from doctor's written/spoken word or from equipment or even at patients' home. On the output end, portable health information should be disseminated to patients' families and their general physicians.

Many hospitals are committed to the use of innovative technology and are now providing e access to the entire medical records of the patient. The medical data will be stored for life. Any authorised individual anywhere in the world will be able to access the patient's medical history. A comprehensive National Health Data Network ensuring global best practices in healthcare processes and solutions will ensure efficiency in day to day processes, thereby impacting the key performance indicators—patient services, clinical outcome and financial health of user companies. This will help the companies in creating satisfied patients, lowering operational costs. and create knowledge for the community. A bye product will be an interoperable, standards based healthcare network that will enable the healthcare community to interact and share data in an efficient and secure environment, with the patient in the center of the universe. Revenue Management, Learning Management and CME, Performance Management, including Decision Support and Knowledge Management, and Clinical Information Systems will form the core of the system

Today instead of hospitals, doctors and patients we talk of the health care ecosystem, a recession proof, exponentially fastest growing industry, with systems and processes designed, to achieve a sigma six standard. We talk of health care providers and consumers not the doctor and patient of yesteryear. Today, Health is considered too important to be left to mere doctors. It has been realized that to attain equitable, sustainable, quality healthcare for 1.3 billion a radical transformation, in fact a revolution, is required, not the marginal incremental growth achieved in the last few decades. 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 750 million Indians, have no direct access to secondary and tertiary care, having to travel 40 to 100km, as 80% of India's specialists, primarily cater to 20% of the population. Adoption of HCIT could go a long way in bridging the urban rural health divide.

1.10 Why digitize?

Recognizing the change in technological innovations, more hospitals are now adopting ICT to improve the quality of healthcare delivery. ICT bridges distances and provides access to clinical knowledge leading to better quality healthcare. Disseminating information and knowledge management with ICT will empower all stakeholders. This will improve outcomes faster and more cost effectively, than only developing better drugs, better surgical procedures or improved diagnostics. In the future integrated health records of patients, smart cards, radio frequency identification tags to track patients, medication management, etc will form the core

of the health care system. Introducing new technology in an existing health care system is one of the foremost challenges of "Digitizing". "Digitizing" a medium sized hospital involves integrating 300-plus applications supporting thousands of processes operating simultaneously in a hospital at any given time. Process redesign to increase efficiency and efficacy is mandatory in the fast-changing healthcare environment. Hospitals are people intensive enterprises and capacity of the people to embrace change is a major challenge. The functional requirements for adequate automation support of clinical healthcare activities far exceed those of any other industry. For instance, most industries do not need to maintain 24/7, 365-days-a-year service with absolutely zero tolerance of downtime. Ultimately, healthcare is delivered by the people for the people. The capacity for staff to accept and embrace change will make or break solutions because ultimately it is the people who are implementing the solutions. Large Investments in money and time is required.

1.11 Conclusions

The ultimate success or failure of implementation of HCIT will not be not due to technological glitches, or lack of funding , or even red tapism. It will be due to human inertia, lack of involvement, commitment and the passionate burning desire, so necessary to break traditional barriers. To paraphrase Don Quixote in "The Man from La Mancha" – "to reach the unreachable star, it is my quest to follow that star, no matter how hopeless no matter how far". What we require today are Don quixotes.History has shown time and again that what is unreachable today is reachable tomorrow.

It was Rudyard Kipling who once remarked "What do they know of England, who only England know". In the 21st century this aphorism could be replaced thus "What do they know of healthcare, who only medicine know". 21st Century is the age of informatics. Today's doctor needs to be as well versed in the basics of Information Technology as he/she is in anatomy, physiology and pharmacology No man is an island unto himself. In the 21st century the physician or surgeon is only a member of a multi disciplinary healthcare team which necessarily must include experts from various domains. Information Technology should necessarily be an integral part of any modern healthcare system. Having been trained in the BC era (before Computers and Before Christ are essentially one and the same!!). the author has witnessed the growth and development of medical care in the last 42 years in India including the gradually increasing use of HCIT in the last few years. . It would be no exaggeration to state that IT has made, is making and will continue to make a significant difference in patient care. Whether it be in the field of diagnosis, investigations, treatment, documentation, retrieval of information, access to state of the art knowledge, medical instrumentation, teaching, research etc IT has made a major difference.

IT in healthcare will level the playing field. It will bridge the gap between the haves and the have nots. In spite of the obvious short term and long term benefits it is a matter of deep concern that the use of IT in the healthcare industry is far less than its use in banking, commerce, travel, automobile or almost any other industry. Less than 2 per cent of gross revenues are set apart for deployment of ICT, compared to 5 to 8 per cent in most other industries. IT improves patient care, by enabling processes and systems to be introduced and repeatedly monitored. Standard operating procedures and audit processes can be introduced in

almost every aspect of healthcare. We not only have software and hardware we have the most precious commodity brainware.

Providing quality affordable health care to anyone, anytime anywhere, making distance meaningless and Geography, History will be the new mantra. This is what digital health is all about. In India, mHealth could be the specific answer to improve the quality of care, without significantly increasing costs. While several pilot projects and proof of concept validation studies have been carried out, confirming that IT in healthcare can make a significant difference, these need to be scaled up. A solution is not a solution unless it is universally available. The time is now ripe to go all out and make sure that in the next decade India will be in the forefront of e-Health. Improbable? Perhaps impossible, No. Will non availability of HCIT in a hospital be considered malpractice in a court of law ? In a decade from now, the response to the above provocative query could very well be a resounding ***Yes ! Yes !*** For HCIT 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, will be the deterrent factors.

The most important enabler to make these breakthroughs come true, is not further advances in technology alone, but meticulous attention to **WIIIFM** for every single stakeholder in the entire ecosystem. The question "**W**hat **I**s **I**n **I**t **F**or **M**e" has to be satisfactorily addressed. With private players playing the major role, particularly in secondary and tertiary health care it behaves them to extend their reach, embrace HCIT and thro PPP modes join hands with the government and make universal health coverage a reality.

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2 Telehealth in India: An Overview

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"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, every time, everywhere"

2.1 Introduction

Every sixth human on planet earth lives in India. Living in 29 states and 7 Union Territories 1300 million individuals, occupy an area of 3 million sq km. Health is essentially a state subject though the centre also spends on health through centrally-sponsored schemes. Government has a three tier system – primary health centres catering to a group of villages, secondary level health care centres located at district level and medical college hospitals in the state capitals and some in tier I and tier II cities. In addition there are advanced medical institutes of national importance having clinical, teaching and research facilities, in most super-specialties. In spite of serious attempts by the state and central governments to augment number of hospitals, medical colleges and produce more doctors and nurses, the urban rural health divide continues.

India is a paradox. We can plant a flag on the moon, send an indigenous satellite to orbit Martian space and launch 82 satellites in quick succession from the same rocket. 200,000 individuals come to India from overseas for complex medical and surgical treatment at 30 to 40 % of the cost, with outcomes comparable to the best. At the same time, we have a long way to go, to achieve the minimum norms prescribed by WHO, in terms of doctor patient ratio, hospital beds. maternal mortality rate, infant mortality rate etc . Deploying *Information and Communication Technology* is the only way to radically transform health care delivery in India and bridge the urban rural health divide. Today it is easier to get hardware, software, middleware, brainware, and even connectivity, than to physically locate tens of thousands of health care providers in India's 650,000 villages. We can today not just piggy back or even leap frog but actually pole vault. *DISRUPTIVE INNOVATION* is what is required today. Anyone, anytime, anywhere, scalable ubiquitous healthcare, with no legacy systems to disinherit, is what digital health offers and this is the only answer . There is an acute shortage of physicians (one per 1681 people) and nurses (one per 1711 people) and healthcare facilities (one bed per 1110 people) in the country. India needs to build at least 750 hospitals of 250 beds each, every year, to achieve the minimum standards stipulated by the World Health Organization. This involves recurring annual expenditure of USD 5 billion.

80% of Indians living in suburban and rural areas still do not have access to basic secondary care. The author in a study (https://www.ncbi.nlm.nih.gov/pubmed/25947977) *demonstrated that 935 million Indians lived in areas where there was not a single neurologist or neurosurgeon.*. While we have touched the billion mark in mobile phones and mobile

internet usage is growing exponentially, lack of power and dependable broadband and hi speed connectivity in rural India is still a problem. India is not a country but a world by itself. The 36 different states have different levels of growth and development, availability of technology, awareness of telehealth etc. Most doctors in India still believe in practising TLC(tender loving care) personal interaction and empathizing with a patient rather than depending completely on big data analytics, provided from wearable technology, which is now a fashion in the west.

WHO defines e-Health as "…the cost-effective and secure use of *Information and Communications Technologies* in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research..." (Resolution 58/28 of the World Health Assembly, Geneva, 2005). This article will be limited to a discussion on the birth, growth and development of telehealth – earlier known as telemedicine. Telehealth is a term encompassing all methods used to examine, investigate, monitor and treat, with the patient and doctor, physically located in different places. Tele is a Greek word meaning “distance” and Mederi a Latin word meaning “to heal ” .One transfers the expertise not the expert. 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. However 700 million Indians, have no direct access to secondary and tertiary healthcare, having to travel 40 to 100km. The National eGovernance Plan has mGovernance as a major division showing the unprecedented growth and development in ICT. Digital information is also easy to disseminate, widely available, relatively inexpensive and can level the playing field. Incremental changes cannot provide the solution. A radical transformation is required. Distance has to become meaningless and Geography has to become History !!

India being a heterogeneous continent, one size will not fit all. Models will have to be customized and tailor made to suit, specific requirements. A major deterrent to the adoption and growth of teleHealth in India is the difficulty in optimizing a business model which will cater to all stake holders in the eco system. Most telemedicine projects in India as in other countries in the world *are not self sustaining, as revenue generation is a major issue*. The problem is not technology, not even lack of human resources, the problem is **WiiiFM** (**W**hat ***i***s ***i***n ***i***t **F**or **M**e). Unless there is adequate incentivisation for the healthcare provider (doctor, nursing assistant) telehealth is unlikely to take off. Philanthropy at best can start a project but will not sustain it without a business model. Individuals who need remote healthcare the most, are those who can afford to pay the least.

High quality medical services can be brought to wherever the patient is, rather than transporting the patient to distant and expensive tertiary care centres. Images are digitally forwarded to the specialist. Immediate electronic access to specialists saves time, costs and reduces the enormous physical effort, normally required of a patient, in travelling long distances. Text, reports, voice data, images and video can be transferred. Through cost effective video conferencing, expertise available in the cities can be transferred to suburban areas. Ultimately standard of health care in rural areas will be increased, and costs reduced. Studies with telemedicine have revealed high levels of satisfaction among patients, general practitioners, specialists and technologists.

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 750 million Indians, have no direct access to secondary and tertiary care, having to travel 40 to 100km, 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 1998, the author foresaw that it could be possible, to extend the reach of urban doctors to suburban and rural India, virtually (**Fig 2.1**). Simple video conferencing has given way to eHome Visits , providing international teleconsults, tele CME programmes, deployment of internet enabled peripheral medical devices, promoting Health Literacy through eEmpowerment and multi centre grand rounds.


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ASSOCIATION OF
RURAL SURGEONS OF INDIA

Figure 2.1 Attempts at Rural Telemedicine in 1998

2.2 The Indian Telecom Scenario

The Govt. of India's National Telecom Policy envisages even a 'Right to Broadband' scenario by 2020. 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. According to the Union Communication Minister Sri Ravi Shanker Prasad by 2017 India will have 500 million internet users. The Telecom Regulatory Authority of India (TRAI) has confirmed that with 1058 million mobile phones India's teledensity is now 83% with a rural teledensity of 51.75%.According to the Internet and Mobile Association of India and IMRB-International in June 2016 there were 371 million mobile internet users. With every fifth mobile phone in the world in India the billion mobile phones are truly changing the country. mBanking, mEntertainment and mCommerce are growing exponentially. mHealth however has a long way to go.

2.3 History of Telehealth in India

Indian Space Research Organization (ISRO) was instrumental in recognising the potential of Telemedicine as a unique application of Space Technology for societal benefit. ISRO Telemedicine programme was formally commissioned by Bill Clinton the then president of the USA on March 24th 2000 **(Fig 2.2)**, resulting in clinical telemedicine being formally initiated for the first time in South Asia. The world's first VSAT enabled village hospital at Apollo Aragonda, in Andhra Pradesh, was connected to Apollo Hospitals at Chennai and Hyderabad. 15 years later recognizing this as a truly historic day, the Indian Medical association declared March 24th as IMA National Telemedicine Day.

Figure 2.2 Commissioning World's First VSAT Enabled Village Hospital March 2000

Remote/rural/medical college hospitals and mobile Units have since been connected to major specialty hospitals in cities through Indian satellites. ISRO Telemedicine network covers various states/regions including Jammu & Kashmir, Ladakh, Andaman & Nicobar Islands, Lakshadweep Islands, North Eastern States and other mainland states. Many tribal districts of Kerala, Karnataka, Chhattisgarh, Punjab, West Bengal, Orissa, Andhra Pradesh, Maharashtra, Jharkhand and Rajasthan are covered under the Telemedicine Programme. Presently, the Telemedicine network of ISRO covers about 450 hospitals with 70 specialty hospitals connected to 360 remote/rural/district/medical college hospitals and about 25 Mobile Telemedicine units

Department of Information Technology (DIT) Ministry of Communication and IT (MCIT), Government of India also established more than 75 nodes all over India supporting Research and Development. These included the School of Telemedicine and Bioinformatics at SGPGI and the Kerala Oncology Network. To standardise services of different Telemedicine centres a document, *"Recommended Guidelines & Standards for Practice of Telemedicine in India",* was prepared by DIT, aimed at enhancing interoperability among the various Telemedicine systems being set-up in the country. Unfortunately it has still not been mandated. In 2005 the Ministry of Health Government of India constituted a National Task Force on Telemedicine (the author was part of the committee)

Private players in telemedicine include Sri Ramachandra Medical University, Narayana Hyrudalaya, Mohan Diabetes Centre,Amrita Institute of Medical Sciences, Asia Heart Foundation and Escorts Heart Institute. Arvind Eye Hospital and Shankara Nethralya have put India in the world tele ophthalmology map by the outstanding work they are doing both in terms of quality and numbers.

Capacity Building Apollo Telemedicine Networking Foundation in collaboration with Anna University, Chennai started a certificate course in Telehealth Technology in 2003. This offered a blend of technical, medical and managerial skills. Due to inability to give placements to trainees the course had to be discontinued after six batches. Retrospectively the course was probably too far ahead of its time. SGPGIMS, Lucknow in collaboration with the Uttar Pradesh State and Ministry of Information Technology Govt. of India set up a School of Telemedicine and Biomedical Informatics in its campus. This 2500 sq. metre building housed different laboratories in the field of e health such as Telemedicine, Hospital Information System, Biomedical informatics, Medical multimedia and image management, Medical Knowledge Management, Artificial Intelligence, Virtual Reality and Robotics. The objectives were to create various resource facilities, structured training programmes, research and development provide consultancy to government and private healthcare organizations and collaborate with technological and medical universities. SGPGIMS is providing training in networking, technical, managerial aspects and application of telemedicine to telemedicine projects in Orissa, Uttaranchal, Raibareli and other centers .

2.4 History of Apollo Telemedicine

Aragonda is a village 13 kms from Chittoor a district capital in the state of Andhra Pradesh in South India. In this village, with a population of about 5000, was born Dr. Prathap C Reddy the Founder Chairman of the Apollo Hospital Group. Dr. Reddy acknowledged to be the Architect of Modern Healthcare in India , realised that Telehealth had to be an integral part of the healthcare delivery system. In 1998, Dr, Reddy and his family conceptualized the construction of a secondary care hospital in this remote village. With 30 beds and OP's it would be a centre for healthcare for more than 25 villages in and around that region.

Obstacles and challenges were enormous, starting from lack of continuous reliable power supply, maintenance of equipments, infrastructure and inadequate telephone lines.Creating awareness, motivating the local population, doctors and teleconsultants was a challenge. However, what started as a pilot project and proof of concept validation in 2000 turned out to be a super success story. It was not the hundreds of patients who had teleconsultation who benefited, not only their families not only the doctors in the village hospitals who essentially had daily CME Sessions, not only the city consultants who only now knew what rural medical

practice was but society as a whole. What India needs today is a thousand Aragondas. Improbable yes, impossible no.

128 grand rounds were held between Apollo hospitals Chennai and Aragonda every Tuesday morning from 2003 to 2005. DNB postgraduates and pediatrics super specialists from Chennai reviewed case histories, reports, CT scans. Ultra sound and x-ray images of children. Live Echo cardio grams and color doplers were transmitted to Dr. Premsekhar a pediatric cardiologist in Chennai. More than 250 pediatric echo cardiograms were done in this village hospital in 2002 -03 with telementoring **(Fig 2.3)** . Unfortunately this study, which was far ahead of any similar study anywhere in the world, was not published or publicized.

Figure 2.3 Viewing Tele Echo Cardiography from Aragonda @ Chennai in 2001

In 2001 a demonstration was carried out by the author and Dr,Premsekhar, at the basement auditorium of the Apollo main hospital. In this demo, for the first time in India a neurological tele evaluation and a cardiac tele evaluation was successfully demonstrated with patients in the base hospital of the Sriharikota Launch Centre of ISRO. Dr,.Kasturirangan the then chairman and the distinguished gathering were impressed. It has since been publicly acknowledged that it was this demonstration that convinced ISRO of the feasibility and necessity to embrace telemedicine in a big way. Today ISRO has installed more than 450 VSATs in hospitals, in the remotest area of the country. There are at least 25 Hospitals on Wheels with VSATS connecting them to specialist in tertiary care centres. In the first 7 years, more than 3000 Teleconsultations took place between village hospital in Aragonda and the Apollo main hospital at Chennai and also subsequently with Apollo main hospital at Hyderabad.

The birth and development of Apollo Telemedicine Networking Foundation (ATNF) is a saga in itself. The resounding success of ATNF served as a catalyst for others to join the bandwagon and make telemedicine in India a reality.Over the last 16 years with 153 centers

including 15 overseas, 95,000 tertiary teleconsultations in 25 specialties for distances from 100 to 4500 miles (F**ig 2.4**). Apollo Telemedicine is today the largest and oldest multi specialty Telemedicine Network in this part of the world. **Fig 2.5 and 2.6** demonstrate neurosurgical teleconsults.

Figure 2.4 Teleconsultations from Different Parts of India

ATNF is a Not for Profit Section 25 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. 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 with over 225 presentations in regional, national and international conferences and over 125 publications ATNF has even been cited in a European Atlas of Telemedicine History. The author also initiated the use of telemedicine in neurosciences. Harvard Business school, Wharton School of Business, the London School of Economics, Indian School of Business are among some of the several international organizations who have used Apollo Telemedicine as study material.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. 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 virtual booking service will soon be extended to virtual teleconsults as well. The teleradiology service ensures a turn around time of 4 to 6 hours (45 minutes for emergencies). From 2009, 205 grand rounds in six specialties, have been conducted between different Apollo hospitals using multipoint VC. 31

clinical meetings and conferences with multiple overseas centres have been carried out in addition to webcasting complex unusual surgical procedures . Deploying one of the largest Medical Response Centres globally, over 287,000 voice based triage consults have been handled so far. Home telecare and electronic house visits have been initiated.

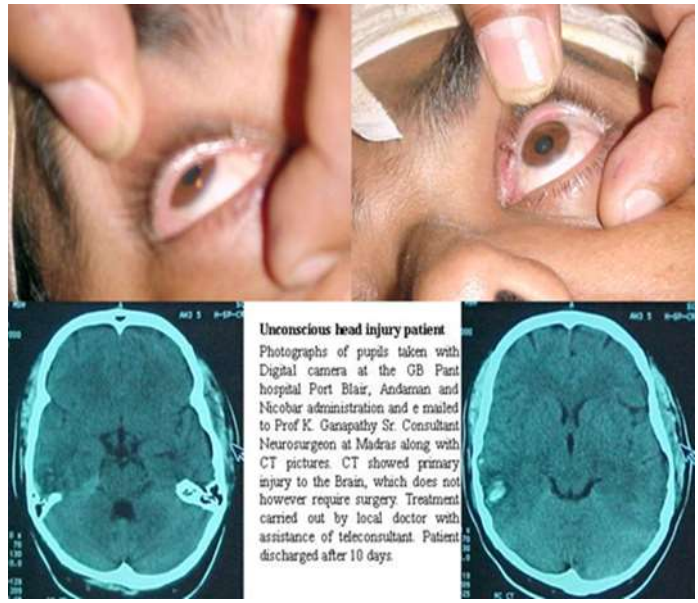

Figure 2.5 A Neurosurgical Teleconsult – Illustration

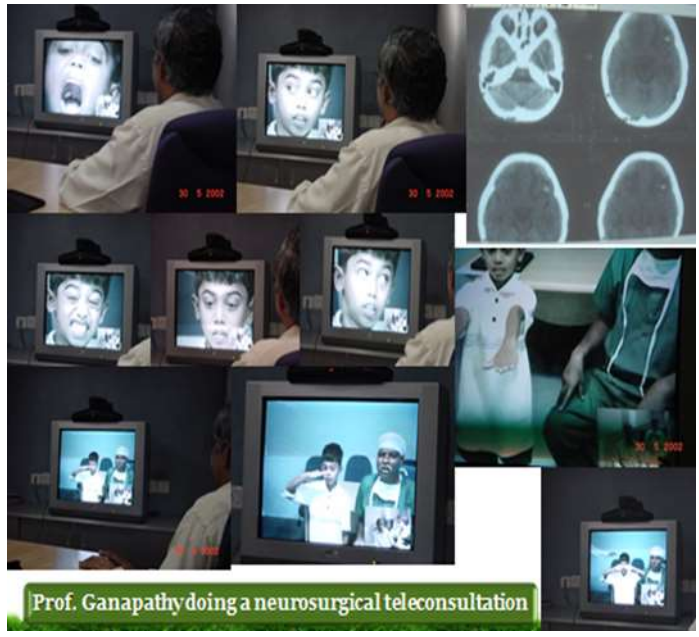

Figure 2.6 A Neurosurgical Teleconsultation in 2002

- **Clinical Applications of TeleHealth** include TeleConsultations – live (synchronous) or store and forward(asynchronous) , Tele HomeCare, Vital Signs Monitoring Services, Ambulatory eHealth ,smart clothing, promoting e Wellness and ehealth Literacy, mHealth, telemedicine through Hospital on wheels. *Tele ophthalmology* In 2013 alone, 306,170 teleconsultations were done in the *Aravind Eye System* including 190,878 new and 115,292 review patients. Sankara Nethralaya has carried out 461,724 teleconsults from Oct 2003. 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 . Ophthalmologists in Karnataka in South India use their iPhones to screen infants in rural and semi-urban areas for retinopathy of prematurity. eICU's 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, hemodynamic monitoring support are provided.

Figure 2.7 Commissioning Remote Health Care in CSC's

- **Telehealth thro CSC:** The essence of the Common Service Center (www.csc.gov.in) system is its equitable geographical rural spread, throughout all states. While planning is centralized, implementation is decentralized. Private entities have been identified ensuring value at the bottom of the pyramid. The local franchisee is from the community, ensuring motivation for social entrepreneurship and acceptance within the users, in the community. Soft loans and essential training are provided to the franchisee called the Village Level Entrepreneur (VLE), by the Government of India, through the CSC SPV (Special Purpose Vehicle) an organization dedicated for this truly innovative project. Government and business services (G2C and B2C) can be accessed at the doorstep, in tens of thousands of villages, increasing effectiveness and efficiency through the VLE. On Aug 25th 2015 (Fig 2.7) the Govt of India formally

commissioned a nation wide telemedicine project. Apollo Tele Health Services was entrusted with the responsibility of providing remote health care to 60,000 CSC's. Creating the necessary awareness and actually implementing a revenue generating and self sustaining business model in the CSC's is indeed an onerous task – which has just begun.

- **Challenges in delivering remote health care through the CSC:** A major cultural transformation had to be achieved to convince residents in far away villages that virtual remote health is feasible. Technical challenges included power outages and low bandwidth. Training and operational issues have to be customised. Delivering quality, affordable accessible remote health care presupposes a dedicated infrastructure, human resources, a robust software and hardware and most important a passionate team which will not take "No" for an answer. Urban teleconsultants need to be sensitized to rural requirements. When functional, the *Jan Aushadhi* units (making available generic medicines) in the CSCs will be a major value added service. A customized insurance plan exclusively for CSC beneficiaries would go a long way in providing the essential cross subsidy.
- **Training programme for introducing Telehealth Services:** As of 31st October 2016 about 13,125 VLEs have been made aware of telehealth including virtual and physical training. A help desk Phone + 91-11-49754975 and Email: *health@csc.gov.in* ensures that all queries are addressed. Periodic Workshops (virtual and physical) familiarize the VLE, about key issues in rural health care and how they could effectively help bridge the gap. VLEs are given a specially designed training manual to understand how to use the tele health service (http://csc.gov.in/images/ CSC_Healthcare_Booklet. pdf).
- The virtual training manual is available both in Hindi and English. To ensure quality control, all teleconsults are recorded. 10% are randomly audited. The Quality-in-charge Auditor listens to a sample set of interactions with different paramedics weekly and measures the professionalism / courtesy and the ability to be easily understood. Using this Audit, the supervisor will use a scale of 100 and rate the paramedic. An escalation matrix ensures that any issue is attended within a reasonable turnaround time. In view of the large numbers, a Training of Trainers scheme (ToT) ensures that all are trained. VLEs are taught to get the consent form signed and electronically fill the case record as a physician assistant would do in western countries. Fig 2.8 illustrates the tele consultation process at a CSC. All teleconsults are scheduled electronically with an ePersonal Health Record. The trained VLE connects the patient to the Apollo Medical Response Centers. The experienced trained doctors who provide the initial teleconsult use an approved Decision Support System to ensure quality health care. If necessary, the consultation can even be escalated to a super specialist. Drugs are prescribed in generic form, from a list of drugs which are known to be available in the vicinity. Dosages are described in user friendly language along with relevant home remedies. Identification of worsening signs, action to be taken and when to get back are also highlighted. The CSC operator takes a print out of the prescription emailed and hands it over to the patient. Clinical quality processes and protocols are being put in place. The possibility of a proper certification of "Rural Health Care Facilitators" is being looked into with a plan for scalability of the front end and backend.

Figure 2.8 Illustration of the process flow of Teleconsultations at CSC

2.5 Telehealth in the Himalayas: A PPP innovation

Nonavailability of quality healthcare in mountainous, isolated, inaccessible sparsely populated regions is a universal problem. In a first of its kind innovative Public Private Partnership Apollo Tele Health services is providing 24/7, quality, affordable, remote health care, to 34,000 citizens of Lahaul and Spiti (height of 14,000 feet in the Himalayas) in Himachal Pradesh. People were commuting 20 to 50 kms for primary and 250 kms for secondary health care services in this mountainous isolated, sparsely populated region. Following a need assessment study, an MoU was signed by Apollo Hospitals in January 2015 with the National Health Mission, where Government bears CAPEX and OPEX and the private organization looks after the entire program management, on a turnkey model. Fig 2.9 shows setting up of the telemedicine centre. As a pilot project and PoC validation, two existing community health centers KAZA and Keylong were chosen.

Tele Laboratory Services were made available using an FDA approved POCD (Point of Care Diagnostic Kit). Blood biochemistry including lipid profile, LFT, RFT, HbA1C, Hb, PCV, were made available at the remote telemedicine location itself. Tele cervical cancer screening has also commenced. A semi trained nurse virtually does a cervical speculum examination and takes a smear after coating with acetic acid. These images are captured and sent to a senior consultant gynecologist in Chennai who reviews the images and counsels the patient. Smears are couriered to Chennai where the slides are evaluated by a trained cyto pathologist. Out of the first six patients for whom this was done, clinically 4 were normal and 2 were diagnosed to have cervical erosion.

Figure 2.9 Setting up of the telemedicine centre @ Keylong in Himachal Pradesh

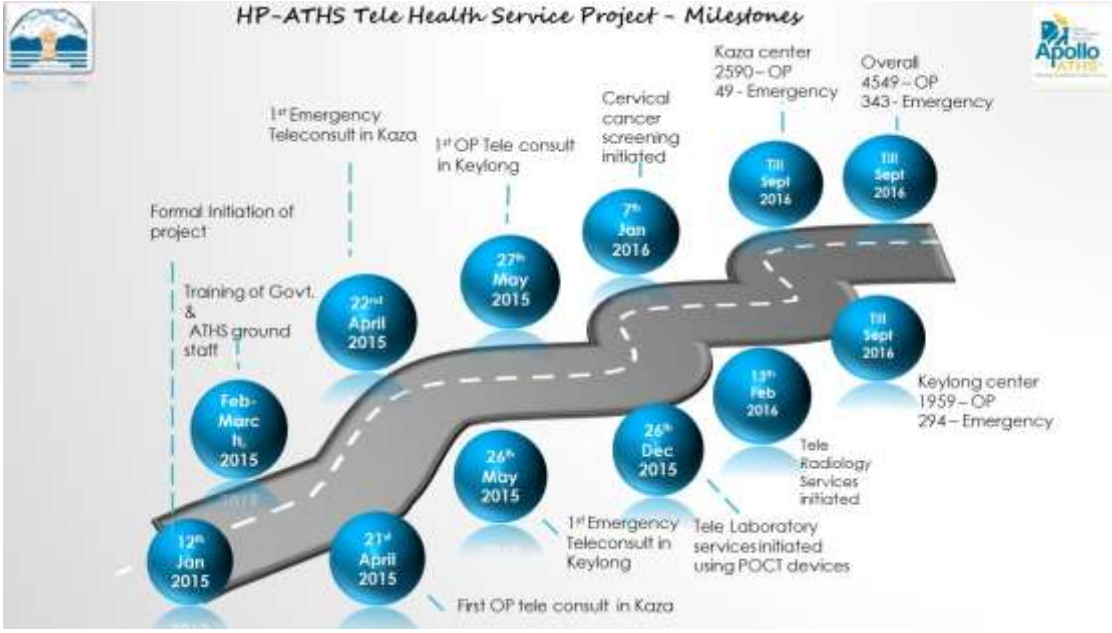

Figure 2.10 Milestones in the Himachal Pradesh telemedicine project

Apollo Telehealth Services customized a turnkey solution, end-to-end, on a program management approach with measurable milestones and monthly reports. Noncompliance to auditable weekly and monthly program MIS would result in penalties. Key health issues in the region were identified. Very Small Aperture Terminals were installed amidst landslides and subzero temperatures. In February and March 2015, staff recruited from the community and

local government staff were trained in Chennai. A major cultural transformation had to be effected. Urban teleconsultants were sensitized for community interaction, while deploying cutting- edge technology. Case records were audited. Evaluation confirms that delivering remote healthcare in inhospitable terrains in a PPP mode is effective. In the last 73 weeks ATHS has successfully implemented a TeleHealth project, in one of the most challenging areas on the planet. 5350 teleconsults have been provided in 17 speciality and sub speciality disciplines including 354 emergencies. Fig 2.10 shows the Milestones in the Himachal Pradesh telemedicine project.

2.6 Other examples of PPP in Tele health care

Another significant development in the last two years has been government hospitals outsourcing reading of images to private organizations. Every few weeks, a state government floats a new PPP tender for some aspect of digital health. Tele call centres and tele dialysis proposals are the new additions. The Government of India, State Governments, the National Health Mission, public sector undertakings and government hospitals are realizing and accepting the fact that building brick and mortar hospitals or making available sufficient human resources physically to provide health care in suburban and rural India will never ever happen. This realisation has resulted in looking at other solutions. In June 2016 Apollo Telehealth services was entrusted with the onerous task of developing 194 ePHC for the Govt of Andhra Pradesh. (http://www.nhp.gov.in/list-of-e-health-initiatives-in-andhra-pradesh-_pg). In this mega project ATHS will be totally responsible for providing virtual specialists and super specialist consultations for a population of almost 10 million people.

2.7 mHealth in the Indian context

The increasing availability of mobile connectivity needs to be exploited by offering healthcare through a mobile medium, popularly known as mobile health (mHealth). The transformative potential of mHealth in India, hinges on acceptance and use. A prospective well designed pan India, in depth study, looking at awareness, willingness, actual use and urban rural disparities in mHealth would help design solutions, build awareness and promote use. With this in mind a statistically valid study was designed to understand the acceptability or otherwise of mHealth in the Indian environment The comprehensive questionnaire administered between Oct 2012 and April 2013. had 31 questions with 620 possible choices. 1886 valid responses were validated and analysed. The study revealed that Rural and Urban India appear to be ready to use mHealth, that mHealth solutions need to be customised to address the several urban rural disparities identified in the study. Ensuring utilisation must include education, empowerment and building trust. With a billion mobile phones most of which are likely to be smart soon, mHealth should in the not too distant future become a reality.

Though mBanking, mEntertainment, mCommerce and mGovernance are becoming a reality, mHealth 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. Video conferencing through mobiles, using 3G and 4G has commenced.

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. In a pilot effort called 'Gramjyoti', Ericsson India had obtained a special license to use 3G spectrum in a pre-defined area (100 miles from Chennai) to showcase the power of 3G and its role in providing value-added services such as e-governance, e-education, e-entertainment and m-health. In July 2008 The Rockefeller Foundation organised a *Making the eHealth Connection* Conference at Bellagio Italy. The author presented a paper on " mHealth: A potential tool for Health care delivery in India". The term mHealth was conceptualised here for the first time. None could have foreseen the phenomenal explosion of mHealth or the utilisation of smart phones in the "third world. .

It is essential to understand the awareness, perception, and attitude of healthcare providers (HCPs) in deploying m-health. Their outlook on new technologies influences patient adoption. Reports on attitudes regarding healthcare through mobile phones are now confined to views from the recipient. The author in a study from August 1 to September 30, 2014 analyzed the views of 592 HCPs (12.3% of all HCPs) in Himachal Pradesh, India. They included faculty and students of the two medical colleges, as well as HCPs from all of the 12 districts. .Although Himachal Pradesh had at that time the highest teledensity of all states in India (117.6%), only 58.8% of HCPs (of those surveyed, 72% lived in suburban areas and 24.8% in Shimla, the state capital) would easily recommend mHealth. Self-perceived ability to use mobile services was 85%. Fifty-nine percent used mobile devices for social networking, and 52.4% used Wi-Fi. Sixty-one percent of those interviewed were females, and 39% were males. The transformative potential of m-health hinges on its acceptance and use by all stakeholders. The study suggests that as HCPs in Himachal Pradesh are already using mobile value added services and are highly IT literate, addressing their specific concerns could lead to use of mHealth in Himachal Pradesh. Healthcare delivery in Himachal Pradesh is still suboptimal. With increasing connectivity, awareness, and commencement of telemedicine services in Himachal Pradesh, mHealth has the potential to be a reality.

A hospital in your pocket: Ideally the mobile phone could become a doctor or even a lab or hospital in one's pocket. Eventually there will be a widespread deployment of sensors, miniaturized hardware and sophisticated cloud based software, accessed thro a smart phone. Fancy video conferencing mobile cameras, robotic telepathology, tele mentoring and robotic tele surgery make interesting news, but do not necessarily change health outcomes for the masses. Providing information and ensuring compliance and adherence thro simple SMS etc should be adopted on a war footing immediately. Mobile communications technologies globally available should be exploited for health care. Processors, which sample signals from sensors embedded on the patient will transmit the digital data over a Bluetooth link to a dedicated server through a GPRS enabled mobile telephone. After analysing the data, appropriate advice would be conveyed. Quick and easy retrieval of health records will be universally available through cloud computing,

Issues/challenges in Implementing Telemedicine?

- Acceptance of this modality by society, patients, family physicians, specialists, administrators and the government

- Designing cost effective appropriate technology connectivity, hardware and software
- Standardising, certifying, authenticating and registering telemedicine units so that minimum safe standards are uniformly adopted.
- Running short term courses to train the trainers and the users
- Drafting and passing a telehealth act for India
- Payment to teleconsultant to make the scheme attractive and viable
- Getting grants, subsidies and waivers to introduce this in suburban and rural areas
- Getting Indian telemedicine units recognised by other countries so that we can provide overseas teleconsults for revenue generation which can be used to subsidise rural telemedicine
- Introducing telemedicine in the medical/ IT curriculum

2.8 Health Literacy

This 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. Consultants have interacted with 21000 villagers in 15 villages. **Fig 2.11** 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. However providing authenticated reliable health information at the right place and right time at an affordable cost can do wonders. Knowledge empowerment in the local language will result in earlier referrals and avoidance of complications.

2.8.1 Operational and Technical Issues

The primary objective of a telehealth unit should be to maximize utilization. If a program is not used, support will erode. If many people use the system frequently, support will be easier to obtain. It is very difficult to stop a program that is delivering a respectable volume of services. An SOP must be customised so that it is cost effective, need based and uses appropriate technology. Attention to minute details is critical. This includes setting up of the telemedicine room, avoiding windows at the back of monitors, having lighting in the front (not the top) .Wrong lighting could result in shadows or diffuse colors that might be confusing while interpreting a diagnostic pattern. Schedules must be maintained for a better work flow. Records need to be archived periodically onto multiple external drives for redundancy and so on. 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. 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. Several publications from India have addressed these and other allied issues.

Figure 2.11 Health literacy Overview

2.8.2 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 one city and the *to be healed* half way across the globe! Telehealth should not result in depersonalization or diminish trust. Tele diagnosis must be followed if necessary 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.

Ethical issues unique to telemedicine, relate to the potential impact on the healing relationship, which go beyond expected challenges of privacy and confidentiality. Loss of touch, potential for depersonalization, possible inequity when distributing benefits of telehealth are some concerns. Improving health care access in underserved populations, and professional expectations in meeting a new higher standard of care have to be considered. Telemedicine could be considered as a potential new form of access discrimination. It will take time for diffusion of this technology into the health delivery system. Theoretically India has the resources. Broadband connectivity is increasingly becoming available and the cost is coming down. Besides tele-healthcare this technology is used for distance education and soon all the medical colleges may be linked, which can bridge the deficiency of teachers and

medical library facility. Most of the telemedicine projects are driven by the doctors and the success is entirely dependent on human rather than technical factors. Awareness among patients and health administrators is essential to accept this emerging technology as a facilitator for quality healthcare delivery in remote areas. There is a need to address policy issues like standardization, legal, ethical and social factors besides developing revenue models and creating infrastructure for meeting the need of training manpower and carrying out research and development. Though startup projects are successful, models should be developed to sustain it.

India with its multicultural heritage and diversity is a paradox and so ATNF had to work hard to overcome challenges faced during its journey. Changing the mindset of the people was as challenging as getting funds and appropriate technology. Though pilot projects were launched, progress was excruciatingly slow due to paucity of capital infrastructure or perhaps more importantly the lack of commitment and involvement, and a refusal to change the traditional mind-set. The presence of 36 official languages, varying literacy levels, and diversity in social, economic, technological, and telecommunication development, contribute to the complexities involved in introducing telemedicine in India. Creating a uniform national telemedicine infrastructure for a multicultural society with conflicting values, norms, interests and ethical issues and implementing eSecurity and ePrivacy for 800 million living in suburban and rural India, and 400 million in urban areas, is indeed a challenge.

Awareness of telemedicine must permeate throughout society. Tele diagnosis has to be followed up by appropriate referrals for investigations and subsequent management. To achieve this, universal insurance is necessary. Telemedicine is an excellent CME medium educating the non specialist. The knowledge that a specialist is always virtually available does wonders for a rural physician's morale. The exponential growth in ICT, the plummeting costs, and the increasing awareness of telemedicine, leave no doubt that telemedicine will certainly revolutionize healthcare delivery in India sooner rather than later.

The only way to make TeleHealth work better for patients is to provide " patient delight " and a customer experience which will make them come again and again. For this, all players in the act need to be trained and re trained .They not only have to learn and relearn but more important also unlearn if necessary,what is currently been deployed in a face to face encounter. We have not yet reached the stage where the stake holders are passionate about TeleHealth. Analysis of successful and failed TeleHealth project around the world clearly indicate the difference between success and failure is the presence of a passionate leader who totally believes in TeleHealth.

Geographic isolation contributes to inequity in health care. It is easier to set up an excellent telecommunication infrastructure in suburban and rural areas and increase the reach of the limited number of urban specialists than to make available specialists in tier II or Tier III cities. Broadband is becoming increasingly available even in suburban areas Digital information is easy to disseminate, widely available and relatively inexpensive. Telemedicine can change the way healthcare can be delivered to the common man, *People in townships and factories no longer have to travel to metros or state capitals for specialty treatment*. Though scores of pilot projects have been launched (more pilots in Telemedicine than in the IAF !) progress has been slow, due to lack of commitment, involvement and refusal to change the traditional mindset.

Today's multi point video conferencing systems are so sophisticated that different specialists can simultaneously interact with a patient. Minute facial expressions can be discerned with unbelievable clarity. Participants remain in view, at all times making it literally a face-to-face meeting. The spontaneity, naturalness, and interactivity of a conventional person-to-person meeting are all there – excepting that the patient and doctor are hundreds or even thousands of miles away. Issues can be addressed and multiple opinions obtained quickly. A non-specialist centre can get a specialist's opinion and a specialist can get a second opinion. Satisfactory transfer of knowledge and information pertaining to patient care, professional and skill development of healthcare providers and administrators, from tertiary, secondary and primary levels are spin offs when telehealth is deployed. This will not only educate doctors but also improve the quality of patient care at these levels. Government and private agencies are venturing into telehealthcare by providing communication links, hardware and software solutions.

Several publications have reviewed the specifc problems encountered in setting up telemedicine units in different areas and 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.. 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. 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.

2.9 Home Telecare

The necessity for home telecare systems is growing due to increase in chronic diseases, aged population (living alone) and medical expenses. A video visit to a patient's home will be more cost effective. Tabletop sensors can monitor blood pressure, cardiac rhythms, blood sugar, and other parameters resulting in signs that can provide an immediate objective assessment. A homebound patient will use a digital camera to take a picture of his post operative wound or bed sore and will upload the photo directly to the medical record via e-mail for his surgeon to see. Intelligent telephones will monitor vital functions from thousands of miles away. A video surveillance unit can watch an old man take his pills, look at his bed sore, and even ensure that the refrigerator and pantry is adequately stocked. I*mplanted* d*evices will directly relay vital parameters through satellite telephones enabling monitoring from a distance.* The Indian dominated Touch lab at MIT in Boston is hard at work to ensure that within a few years even the sensation of touch can be perceived remotely.

2.10 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) for common e-Education. National Resource Centers and Regional Resource Centers for NMCN have been identified. High speed optic fiber 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.Though utilisation is suboptimal, there is optimism.

2.11 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 tele ophthalmologist in the tertiary care center. 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 multipurpose 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. Fig 2.12 Remote clinical evaluation was followed by ePrescriptions . Subsequently similar telecamps were held in different parts of Tamilnadu in southern India. Providing well-equipped mobile hospitals is another pioneering initiative from the Apollo group. As part of the Distance Healthcare Advancement Project, Apollo Hospitals along with Philips Medical Systems, ISRO and the DHAN Foundation (a nongovernmental organization), created an ecosystem where quality healthcare was provided through a Hospital-on-Wheels (HoW) Fig 2.13 Global Telehealth Initiatives of Govt of India.

Figure 2.12 Mega Multi Speciality Telecamp Apollo Telehealth Services

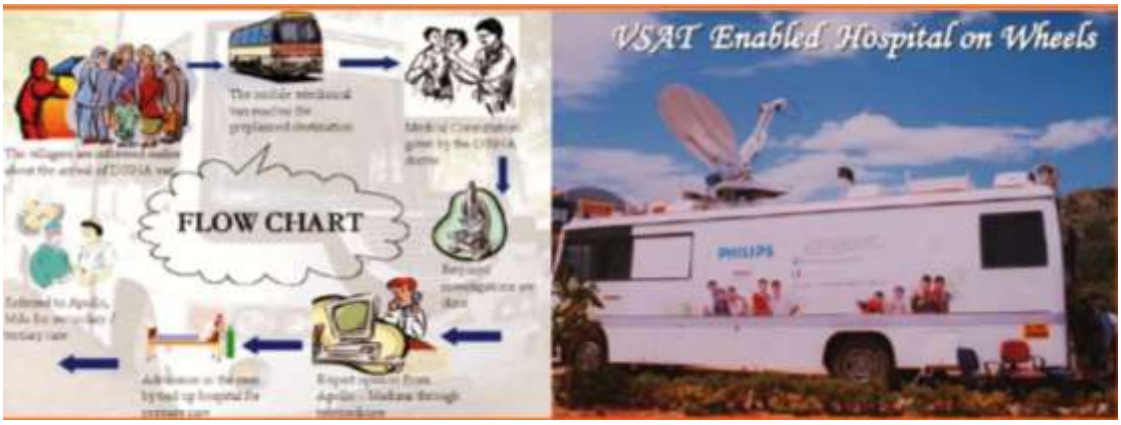

Figure 2.13 Hospital on Wheels Initiated in 2005 by Apollo Hospitals and ISRO

Figure 2.14 CME program thro PAN project

Figure 2.15 Neurosurgical Teleconsult to an African Country

The Ministry of External Affairs, Govt. of India initiated the Pan Africa e-Network project for teleconsultations in 2009 .Through this network Apollo Hospitals Chennai is connected to 42 countries in Africa. **Fig 2.14** shows the author giving a CME program to doctors in Africa.

Fig 2.15 shows a neurosurgical consult in progress. Under Graduate, Certificate and Diploma Programs in various disciplines through distance education via on-line teaching hosted at each of the Indian Universities are available 2,500 lectures have been delivered for doctors in Africa through this network.

The SAARC e-Network for South Asian Countries and the ASEAN network is being followed by the Central Asia e-Network Project. The5 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 Super speciality 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,

2.12 Future of Telehealth

Patients will no longer be passengers in a vehicle driven by doctors. They will travel in driverless cars! They will increasingly be responsible for their own health. Real time access to electronic information on new technologies and treatments will make them empowered patients. They will not just be checking their BP and blood sugar but critically reviewing different treatment options!! Medicine of the future will be wireless. Implanted Devices will be able to communicate directly with the monitoring systems located tens of thousands of miles away. Bluetooth enabled devices will communicate with insulin pumps implanted in the body and insulin will be automatically released when required, even without the knowledge of the subject. Today telemedicine is slowly making inroads into health care. Tomorrow it will be mHealth (the broad term deployed in the use of the ubiquitous ever increasing all pervading mobile devices in providing health care). Telemedicine's champions will have to work hard to make sure that investment decisions are made with respect to the future, not the past. Easy to use, should be a prerequisite in the selection of equipment and systems for telemedicine. User-friendly, it must enhance, not hinder the process of health care. Telemedicine will encounter considerable resistance as it moves from the fringe to the mainstream of healthcare, over the next decade. Deciding how to pay for it, who is qualified to do it and how to assess its quality are already major issues. Teleconsultation is not a new medical service but a new way of delivering a consultation. With a billion mobile phones most of which are likely to be smart soon, mHealth will be the order of the day.

Wearable computing devices will transmit every conceivable information to the health care provider. A wearable Motherboard will be a "platform" for sensors and monitoring devices that can unobtrusively monitor the health and well-being of individuals (directly and/or remotely. With rapidly reducing costs, quality of care will increase exponentially. eHealth will become iHealth (interactive health)--all aimed at enhancing the quality of life. Online pharmacies will access the doctor's prescription and deliver drugs to the patient's home. Side effects and drug interactions can be seen on one's mobile. The tele specialist of the future will offer advice from his smart phone / tablet wherever he/ she is. The patient need not wait for the next day's " rounds"

Telehealth in the next decade should not be viewed as a distinct specialty or a new discipline as it is now. Telehealth is only a means to achieve an end and not an end by itself. It is an enabler and therefore should be incorporated and integrated into the entire healthcare delivery system. We are in a stage of transition. All transitions offer great opportunities.

During the period of transition, there will be scores of issues which needs to be identified, recognized and solved. In the next decade telehealth will be totally embraced universally for the simple reason that there is no other solution worldwide to provide equitable health care.

Health care, in the ensuing years, will essentially be DIY – Do It Yourself. Registration regulations in medical practice have to be reviewed. Hospitals without walls, cyber hospitals and virtual hospitals have already become a reality. Exponential growth of *IT* is resulting in extraordinarily increased access to health information and opportunities for telemedicine practice across continents. To respond to the change offered by the telecommunications revolution, we need to design a new regulatory structure for the 21st century. International telemedicine licensure will expand the market for telemedicine Could *not* having a Telehealth Unit in a hospital be considered deficiency in service ?In a few years from now, the response to the provocative query raised in the title could very well be a resounding *Yes ! Yes !*

As Walter Hugo had once remarked " Nothing can stop an idea whose time has come" . The writing on the wall suggests that the telehealth movement will soon reach the critical mass essential for a successful take off. Medical doctors and hospital administrators play a critical role to maintain this momentum and need to understand that the future is always ahead of schedule.

2.13 Conclusions

The take off problems, facing telemedicine is legion. It is our dream and hope that within the next few years there will be telemedicine units in most parts of suburban and rural India. Eventually no Indian will be deprived of a specialist consultation wherever he/she is. Consultation will soon be only a mouse click away !! This is not impossible. For this to happen, a critical mass must be reached. What is required is not implementing better technology and getting funds but changing the mindset of the people involved. Awareness should permeate throughout society. Real growth will take place only when society realizes that distance is meaningless today, and that telemedicine can bridge the gap between the "haves" and the "have nots," at least in so far as access to healthcare is concerned. Accessible quality healthcare to anyone, anytime anywhere at affordable cost, will be the new mantra. With private players playing the major role, particularly in secondary and tertiary health care it behaves them to extend their reach and provide health care particularly where it is not available.

The first generation of telehealth enthusiasts should not forget that technology should be used as a support to treat patients, not viewed as a goal in itself. The challenge today is not confined to overcoming technological barriers, insurmountable though they may appear. It is true that available technology still has considerable scope for improvement. Rather the challenge is why, where and how, to implement which technology and at what cost. A needs assessment is critical. Previous generations of physicians will find the new concepts of telemedicine unfathomable. To many, it may sound blasphemous. What will happen to the individual doctor patient relationship considered sacrosanct for centuries? Is it not sacrilegious and bordering on heresy to treat a patient in another continent without knowing his family and cultural background? Yes, say the diehards. No, say the technology enthusiasts. To treat sick people, empathy and understanding is needed.

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3 National Knowledge Network

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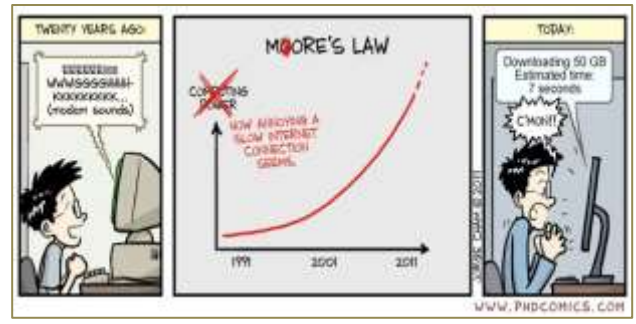
3.1 Introduction



Some time ago, I came across the cartoon in www.phdcomics.com and I reproduce it here. The message conveyed by the cartoon is obvious. Compared to the speeds that were available to the users a few decades earlier, today the user expects significantly higher speeds from modern networks. While the user was happy with a few Kilobits per second earlier, today the user expects and often demands hundreds of megabits or even Gigabits per second for himself or herself. This is no simple comic! It tells a story of the rapid growth of a technology during our lifetime and we all experience it personally.

Information and Communication Technology (ICT) has played a pivotal role in linking people, institutions and regions within the country and globally by providing increased connectivity and further elimination of information barriers. ICT has been recognized by United Nations as the key growth driver for world economy in the twenty first century. Education and healthcare – the two fundamental factors of development – are expected to gain enormously through use of digital technologies worldwide.

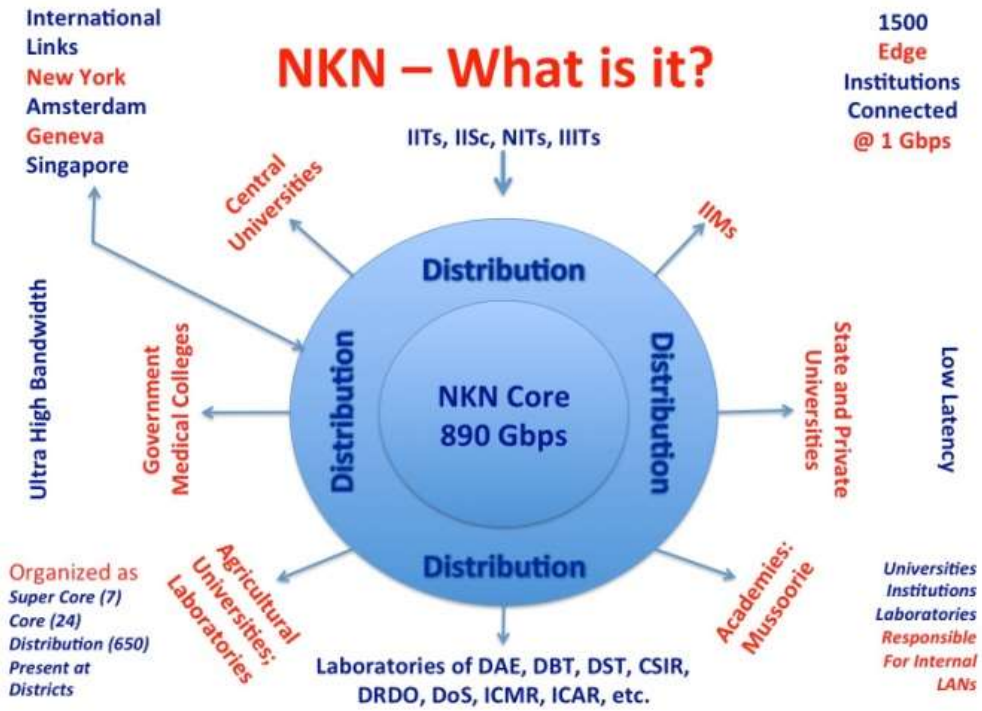
National Knowledge Network is the Critical Infrastructure for India

ICT has been instrumental in providing impetus to the growth of the knowledge economy by enabling access to a wider pool of knowledge, which is available with the multiple knowledge creators and through different platforms. ICT has certainly helped the different stakeholders of this knowledge economy such as the scientists, professionals, scholars, students and doctors in their endeavors by providing them easy access to the desired information. This transformation in information flow has led to the genesis of National Knowledge Network (NKN), which is a significant step towards ushering in a knowledge revolution in the country.

3.2 NKN in a Nutshell

National Knowledge Network interconnects all knowledge institutions across the country through a high-speed data communication network to enable sharing of knowledge resources and to carry out collaborative research. NKN is the platform to bring together all stakeholders

in the knowledge domain - scientists, researchers, doctors, and students with different background and from diverse geographies. Such synergistic integration encourages the stakeholders to work closely for faster development in critical and emerging areas, using structured *knowledge-sharing* framework. In effect, NKN has brought about a paradigm shift in the education, healthcare and agriculture, by eliminating the constraints of distance, time, and physical location. Besides, National Knowledge Network encourages and enables the use of specialized applications, which allow sharing of high performing computing facilities, e-libraries, virtual classrooms and large databases.



National Knowledge Network is a significant step, whichenables scientists, researchers and students from across the country to work together for advancing human development in critical and emerging areas and bringing about a knowledge revolution that will be instrumental in transforming the society and promoting inclusive growth.

NKN provides connectivity to 1500+ nodes, covering all major institutions. The decision to set up National Knowledge Network was announced in Indian parliament in 2008-09 with an initial allocation of INR 100 Crores to the Department of Information Technology, Ministry of Communications and IT. However, the real impetus to this initiative came when the Cabinet Committee on Infrastructure approved the establishment of National Knowledge Network as a mission mode project in March 2010, with an outlay of INR 5,990 Crores, to be implemented by National Informatics Center (NIC) over a period of 10 years.

3.3 NKN and Uses in India and Cooperation Worldwide

NKN is a Research and Education (REN) network for India. The experience of using advanced networking has been extremely good in high-energy physics, as seen from CERN cooperation worldwide. Of course, one can even say that "without high-speed and low latency" interconnections, countries involved could not have made such rapid advancement. This raises the natural next question, out of scientific curiosity. What next?

1. From *watching the universe* to *looking in to the atom* the world of science knows the art of generating enormous data leading to fantastic scientific insight. Natural next question is: *"What is the process of consolidation of such data for posterity (perhaps for re-analysis to test a new hypothesis) and what is the process of consolidating and reconciling the new data that will be generated at a rapid rate in future?"* This requires a joint effort by several scientists in Indian NKN as well as EU RENs. Perhaps a beginning was made in this direction in ICRI Conferences 2012 and 2014. This needs to continue.
2. Astrophysics, Climate change, and high-energy physics have laid the foundation for Big Data Science. The next in line seems to be ***Personalized Medicine*** motivated by several scientific findings in bio-related analysis – molecules, informatics, genetics, proteomics, clinical studies, cell biology – to name a few. Perhaps, focus on integrated programs along these lines – as identified by scientists and clinicians – will be a natural next step.
3. Of course, Computer Science and Communication Infrastructure will have to lend their benevolent arms (perhaps many-fold) to enable all these.

These could be some pointers for the next steps in evolving NKN as the eScience infrastructure of future.

3.4 Using NKN for Medical Education and Healthcare

As mentioned earlier, National Knowledge Network (NKN in short) is an all India network that interconnects 1500 knowledge institutions in India. Some examples of the institutions are, IITs, NITs, IIITs, Central Universities, Government Medical Colleges, Agricultural Universities, national laboratories of DST, DRDO, DAE, DoS, MoES, and several other specialized institutions. Of course, notable medical institution that is on the forefront of using NKN is the All India Institute of Medical Sciences (AIIMS), New Delhi.

Use of NKN: NKN is a high bandwidth and low latency network. That means the user experience will be enhanced when two-way interaction is required, like in a classroom. One of the early uses of NKN was "remote teaching" using a virtual classroom. For example, AIIMS faculty can teach "local" students in AIIMS, while at the same time let students in several remote medical colleges listen to the "same lecture" and interact, whenever necessary.

AIIMS and NKN: AIIMS, Delhi completed a Model Project in establishing Medical Classroom by bringing together 6 to 7 institutions for teaching courses. They developed course material as well. Many of these courses, we believe, are available in digital form in AIIMS. The feedback session was encouraging with positive experience being reported from remote sites.

In another Model Project, Center for Dental Education and Research, AIIMS New Delhi along with CSIR-CSIO, Chandigarh (CSIR national laboratory) and National Informatics Center (NIC) implemented a 3D imaging facility - *using CollabCAD software developed by NIC, algorithm perfected by CSIO, and application endorsed by AIIMS* - for dental imaging. Encouraged by the success the project team is extending it to 6 other medical institutions. The team is also exploring new vistas in 3D printing of dental implants.

Medical Education and NKN: Recent advances in areas such as *Neurosciences and Personal medicine* require an all round appreciation of issues from science, engineering, mathematics, and medicine. Advanced courses in these areas are possible only by bringing together

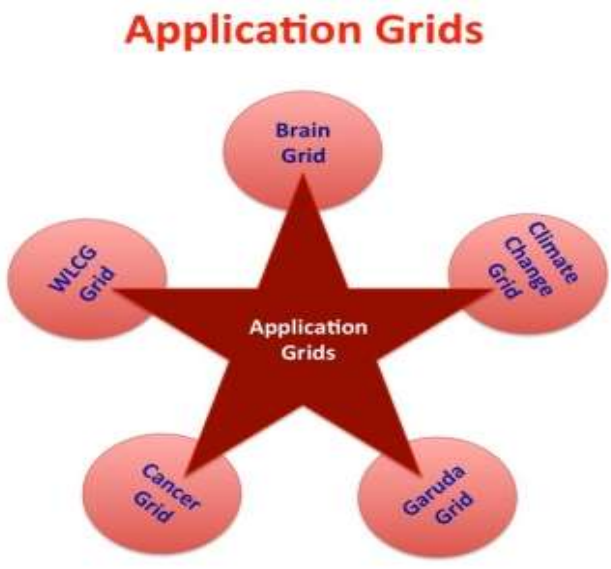
"experienced faculty" from various institutions for offering a single course – perhaps under the aegis of AIIMS. Use of NKN may also be explored for sharing "rarest of the rare" cases that one comes across in the medical institutions connected to NKN.

Healthcare and NKN: One possibility is to build a Project for health delivery and for the management of health referral chain. For a comprehensive understanding of possibilities the reader is referred to the XII Plan document on Health.

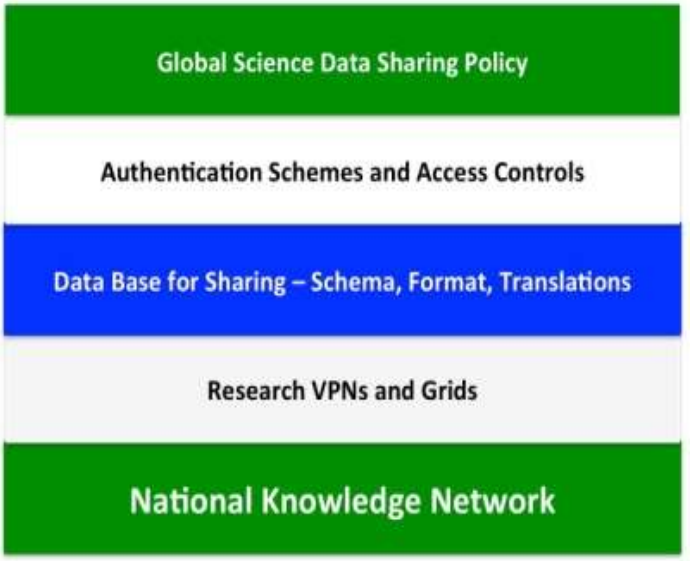
3.5 NKN and Cancer Grid

Forming grids consisting of users from a focused application in the medical use enhances the impact of NKN in Knowledge Integration and Direct Societal Benefit. National Knowledge Network (NKN) is the e-Infrastructure of India connecting knowledge institutions across the country at speeds1 Gbps or higher. Besides, NKN is connected to all leading research and development networks across the world; in particular, USA, EU, Japan, and Australia.

The users connected to NKN are organized into several Grids. Examples are, Cancer Grid, Brain Grid, Climate Change Grid, and so on. In technology terms, Grid consists of users across organizations forming Special Interest Groups (SIGs). It is also possible to form sub-grids. For example, one can have a disease specific or modality specific subgrid under Cancer Grid.



In the case of cancer it is observed that science behind understanding cancer, clinical practices, and emerging new modalities in imaging and diagnosis have tremendous inter-dependency and there is an opportunity to carry out interdisciplinary research - both basic and applied. Obviously, it involves scientists of various hues, interacting with practicing clinicians and engineers who can bring in machine learning and fine imaging. Of course, establishment of disease related biomarkers is a fundamental area that appears to remain relatively unexplored.



Cancer Grid is an attempt by NKN to provide the conceptual integration of science, engineering, and medicine by bringing together the researchers in various knowledge institutions across the country.

Data Sharing: Research and Education data sharing is a serious issue especially when multiple groups are involved and large research data is continuously generated. TO share such large volumes of data in raw or processed form online and in real-time requires careful planning. While NKN can act as a base, the individual research groups, who are in various grids have to come to a complete understanding among themselves about the process of sharing. A generic approach to addressing the problem of data sharing is given in the adjoining figure.

3.6 NKN Data Architecture

NKN is emerging as the basis for Science research and Education in India and for Indian scientists' interaction globally. In fact, large global science projects such as CERN, LIGO, SKA, are based purely on the availability of NKN.

University consortia in Astrophysics, Climate Change, Genomics, Proteomics, High Energy Physics, Brain Understanding, Human Simulator, and so on owe their origin and sustenance to NKN.

Maintaining NKN with contemporary technology and being ahead of global changes dynamically is a constant challenge. NKN provides great opportunity to be a global leader in many areas of technology and standards, thereby strengthening India's hands in global negotiations.

3.7 NKN R&D and Technology Upgrade / Induction in Future

NKN has fundamentally altered the approach to research and education networking. NKN, together with the increasing social importance of sharing knowledge, has prompted end-to-end engineering of NKN with the aim of improving performance as measured by user experience.

NKN is interested in research studies that focus on automatic learning and selfadjusting approaches, in order to *engineer low latency access* to NKN services. Latency impacts education and interaction.

NKN is interested in extraordinary steps to engineer their infrastructures to achieve millisecond-level latency improvements, by improving transmission technologies, aligning routing and topology with geography, ensuring service proximity to users, and optimizing delivery of contents, which are increasingly becoming high definition multimedia. Perhaps, realizing some of these solutions in NKN is the agenda for networking research in NKN.

Technology Upgrade to 100 Gbps: National Knowledge Network (NKN) today provides 10Gbps connectivity across major R&D Institutions for research – *1 Gbps for edge connectivity and 10 Gbps in the core*. This needs to be enhanced with cutting edge network technology of at least 100Gbps in the core immediately and multi Tb/s in the future. NKN will continue to serve as the Research and Education network with high capacity in the core and edges.

Going forward, NKN will also be the test-bed for network systems researchers, enabling cutting edge networking technology research in Network Design, Resource Planning algorithms and Network optimization with special focus on Software defined Networking (SDN) and Network Function Virtualization (NFV). Therefore, NKN plans to deploy high-capacity DWDM links across select locations, which can grow into Terabits of capacity aggregated at *per wavelength* speeds of 100Gbps. Networks with such characteristics are built using three building blocks, namely *100Gbps optical interfaces, the connecting physical links (Dense Wave Division Multiplex –DWDM - capable) and interconnected Reconfigurable Optical Add Drop Multiplexing (ROADM) nodes*.

To avoid issues related to maintaining pan-India physical assets in the path, links, which deliver up to 80 channels of DWDM capacity across the selected locations, can be leased from the existing NKN service providers. This ensures NKN researchers can focus on their specific task of networking experiments than spending time on maintaining the physical links. Multiple logical topologies, state-of-the-art Software Defined Networking (SDN) research, specialized algorithms needed to converge a high-speed information network, are some of the focus areas for making a very high-speed network test bed available for NKN.

Multiple links from various Service providers landing at the NKN sites can be connected together to the application/service Routers *using an optical ROADM layer for developing resilient network topologies*. The link level issues will be targeted to be handled within 50ms by the optical layer to provide seamless highspeed networking experience to researchers and other users of the NKN. The ROADM layer can handle multiple fiber cuts or link issues by applying appropriate protection algorithms with agility. The 100Gbps links can be used to share real time data cross research laboratories, facilitate experimentation on NFV and can be used to develop & test multiple applications of SDN.

When NKN evolves as an ultra-high-speed network with SDN controllers, NKN can be used as a high-end multi-tier, multi-technology research and application network for not only the 100Gbps NKN connected nodes, but also other nodes connected to NKN with appropriate open interfaces/architecture made available to them.

3.8 National Knowledge Network (NKN) and Cyber Security

- **Establishing Reliability and Availability of NKN**

NKN is working very well as a network connecting large number of institutions. Applications are not yet operating in time critical mode. For example, while institutions connected to NKN conduct a guest lectures, routine classes for cross crediting are still in the discussion stage. We may be able to accelerate the launch of time-critical applications by establishing an excellent record of reliability and availability indices associated with NKN. As education and health are emerging as anchor applications for growth in new age, we need to address this on priority.

Action points are completing the Dark Fiber experiments, inducting necessary equipment, completing all the Super core and Core links at higher speeds, and establishing the District level PoPs.

- **Reliable Overlay Networks with Dark Fiber**

NKN encourages overlay networks for special users. Special users happen to have dedicated Compute, Database and Information infrastructure that can complement NKN. Besides the

total resource available is likely to create a win-win solution for NKN and special users. This would have a tremendous impact on reliability and availability of NKN in the long run.

NKN as it is defined today comes to a close in 2019. All the points mentioned above will become serious issues to be handled in the 2017-18 and 2018-19. Time to lay strong foundation is now.

3.9 NKN International

At present NKN has direct presence in New York, Amsterdam, Geneva, and Singapore. NKN will progressively progressively extend its arms to Japan, Australia, West Asia, South Africa, and South America, as our Research and Education cooperation deepens with these geographies.

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4 National Health Portal and Centre for Health Informatics

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4.1 Introduction

The National Health Portal (NHP) of India was set up with the objectives of (i) enabling the masses to access reliable, easy to understand, multilingual health information from an interactive NHP to educate and promote health literacy as envisioned by the state; (ii) making reliable and validated health information readily available on the public domain using the Internet, print, radio, television and other pertinent communication modalities, and, (iii) enabling an average citizen to seek, locate and access qualified and registered health care providers across the country. Initially the Centre for Health Informatics (CHI) was set up in a Pilot Project Mode in the National Institute of Health and Family Welfare (NIHFW). With the successful completion of the Pilot Project, it was decided by the Ministry of Health and Family Welfare (MoHFW) to form an autonomous Institute under the Ministry as the National Centre for Health Informatics (NCHI) with a broader mandate to carry on all the eHealth activities of the Ministry, apart from managing the NHP.

The National Informatics Centre (NIC) of India was established in 1976, and has been working as the major player in developing e-Governance and other digital applications in India. However, with passage of time, it was found that there needs to be more focused portals catering to the various informational needs of the citizens.

In the wake of the recommendation from the National Knowledge Commission (NKC, 2007) outlining the need for a National Health Portal (NHP); the Union Ministry of Health and Family Welfare (MoHFW), decided to set up and manage the NHP that would serve as a comprehensive and multilingual source of health information in India. This portal has to provide health information and healthcare-related information to the citizens of India. It has to serve as the first point source of reliable access to consolidated health information, applications and resources on the sector and should aim to cater to a wide spectrum of users from lay people to students, healthcare professionals and researchers.

The NHP was proposed to be built in collaboration with a wide range of stakeholders from all sectors including the Government, academic institutes, private sector and technology experts to ensure the best and appropriate skills are employed and utilized for this endeavor.

Aims: The aim of this initiative was to create a multilingual national health portal for India. The main objectives for setting up this portal included.

- To enable the masses to access reliable, easy to understand, multilingual health information from an interactive National Health Portal to educate and promote health literacy as envisioned by the state;
- To make reliable and validated health information readily available on the public domain using the internet, print, radio, television and other pertinent communication modalities;
- To enable an average citizen to seek, locate and access qualified and registered health care providers across the country

Scope of the Initiative: The NHP involved the development, setting up and management of a multilingual online national health portal for India. The scope included presenting simple, easy to understand health-related information through the portal using various dissemination means to the public in an attempt to address most of their health

Information needs. All health information available on the portal had to be in English, Hindi and in the other major regional languages in India. Information on the portal had to be available in the form of text or static web pages, voiceovers/podcasts, directory services, region-specific health information in the regional language, multilingual translated information, and also accessible through intelligent searches.

The interactive component of the portal involved interactive multilingual health modules, online health tools and widgets, online health forums and blogs.

The communication component included – alerts, updates, News, Really Simple Syndication (RSS) feeds, and SMS alerts (for registered users at a nominal cost).

The dissemination component of the portal included interactive DVDs, short films or videos, touch-screen based kiosks for health information, radio and television broadcasts, and mobile telephony or fixed phone-based health information. To validate the entire portal content experts from the Health Ministry as well as academic institutes had to be involved.

Apart from having exhaustive health content, the portal included information on complementary and alternative streams of medicine such as AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy) and Directory Services for health care provider information, Regulatory issues in healthcare and information on National Health Programs and disaster management. The wide target populations included the general public and patients, healthcare providers (AYUSH and Modern Medicine Practitioners), medical students, special populations and e-learning initiatives for medical professionals.

Goal: Gateway to authentic health information for all.

Vision: The National Health Portal aims to make this as a single point access for authenticated health information for citizens, students, healthcare professionals and researchers.
Mission: The National Health Portal will achieve the above vision by collecting, verifying and disseminating health and health care delivery services related information for all citizens of India.

National Health Portal has evolved in a short span of time after the launch in Nov 2014. New initiatives have been undertaken during the following years to benefit the masses.

4.2 Features

- NHP Voice web (through a Toll-free phone number **1800-180-1104**) is available for getting information through phone calls, especially to reach out people where there is no Internet and also for those who are illiterate. It is currently available in English and five regional languages (Hindi, Tamil, Gujarati, Punjabi and Bangla)
- Mobile applications are being developed to access the NHP through mobile phones.

Web-based

- Information on Health and Diseases
- Information on Directory Services – Hospitals, Blood Banks, Ambulances – according to state / city / PIN Code
- Information on Regulatory Laws, Protocols, Standards, Health Policies and Programs, Committees and Commissions
- Information on Disaster Management, First Aid, AYUSH, Careers
- Professional Information
- General Forum for general discussions among common persons, patients, care givers and healthcare professionals
- Professional Forum for discussion among health care professionals
- Help Desk for Implementation of EHR Standards:http://www.nhp.gorv.in/electronic-health-record-standards
- Forum for discussing implementation of EHR
- Feedback on the content on NHP
- Social Media – Facebook**:** https://www.facebook.com/NHPINDIA
- Social Media – Twitter**:** https://twitter.com/NHP_INDIA also with hashtag #nhportal
- Translation of limited content in Hindi, Tamil, Gujarati, Punjabi and Bangla has been initiated
- Microsite was created for Celebrations of **International Day of Yoga 2015** in India.

4.3 Be Healthy Be Mobile Program mCessation (Quit Tobacco) Program

Tobacco kills almost one million persons in India every year and is the major risk factor for many dangerous diseases. In order to combat this problem, mCessation programme has been started. This service aims to reach out to every single person who is willing to quite tobacco. Any tobacco user can register them by giving a **missed call on 011-22901701** or by registering on the NHP http://www.nhp.gov.in/quit-tobacco for e-registration. Thereafter, a two way SMS process would begin. The NHP has been coordinating this program successfully, in collaboration with the MoHFW, NIC, MyGov and WHO-ITU (Be Healthy Be Mobile program).

Mobile Apps: The first one from the NHP was formally launched on 14/6/15: **NHP Directory Services** for finding ***National Blood Transfusion Council (NBTC) supported Blood Banks*** near you. The subsequent launches are described below.

Launched on 6th April 2016

4.4 NHP Indradhanush Immunization

NHP Indradhanush facilitates young parents in tracking the immunization of their children. The app takes away pressure of having to remember life critical information amidst juggling work and home for the parents.

The objective of National Health Portal, India is to provide healthcare related information to the citizens of India and to serve as a single point of access for consolidated health information. Women and children have always been a focal audience in its vision.

Ministry of Health and Family Welfare (MOHFW) had launched Mission Indradhanush on 25th December 2014 with the aim of expanding immunization coverage to all children across India by year 2020.

Following the same, this mobile app has been developed to cater to parents to help them tracking the immunization of their children. This was launched on **6/4/16**.

Features:

1. User can add baby and corresponding details
2. User can set reminders for each baby on immunization
3. User can add new immunization in addition to the recommended ones The application is designed to work on Android phones for now.

URL: https://play.google.com/store/apps/details?id=com.linchpin.childcare.view&hl=en

Launched on 7th April 2016

4.5 India Fights Dengue

Features:

1. User can check Dengue Symptoms.
2. User gets nearest Hospital / Blood bank information as per current geographical location.
3. User can share feedback via email.
4. Interactive and pictorial display for Ensure Dengue Mosquito free area.
5. User can hear Shri Narendra Modi's Mann ki Baat audio.
6. User can check Myths and Facts for Dengue application.
7. User can view Do's and Don'ts for prevention of Dengue
8. User can view Dengue related Frequently Asked Questions
9. User can view Munnabhai video for Fight against Dengue

URL: https://play.google.com/store/apps/details?id=in.gov.nhp.indiafightsdengue&hl=en

4.6 NHP Swasth Bharat (Disease, Lifestyle, First Aid)

The access to authenticate health information is the primary right of the citizen. Providing authentic Health information to the society is arguably one of the most important factors in improving health outcomes. Inadequate or poor health information can increase the risk of hospitalization or even disease burden.

MoHFW through its eGovernance initiatives is launching a mobile application "Swasth Bharat Mobile Application" to empower the citizens to find reliable and relevant health information. The application provides detailed information regarding healthy lifestyle, disease conditions (A-Z), symptoms, treatment options, first aid and public health alerts.

The application "Swasth Bharat Mobile Application" is an Android based mobile application, which can be installed on any device with Android OS version 2.3 or above. The application will be launched soon for other popular platforms.

Future Plans for the NHP

The NHP will ultimately be available in all the 22 major languages of India. Further, the portal is disabled-friendly too. Initially it is an informational portal. However, with time, it is expected to evolve into transactional and transformational portal as well.

4.7 Transformation of the Pilot Project to an Autonomous Institute

Initially the Centre for Health Informatics (CHI) was formed in a Pilot Project Mode in the National Institute of Health and Family Welfare (NIHFW). With the successful completion of the Pilot Project, it was decided by the Ministry of Health and Family Welfare (MoHFW) to form an autonomous Institute under the Ministry as the National Centre for Health Informatics (NCHI) with a broader mandate to carry on all the eHealth activities of the Ministry, apart from managing the NHP.

The other major eHealth initiatives include the creation of a unique and permanent National Identification Number (NIN) for all the healthcare facilities (large, medium, small, public or private) in the country.

Another major activity will be the creation of an ecosystem facilitating eHealth in the form of an 'Integrated Digital Health Information Platform (IHIP)'.

All these activities are described below in greater details.

4.8 National Centre for Health Informatics (NCHI)

The National Centre for Health Informatics (NCHI) is being set up with the following objectives: Besides being the nodal agency for various e-governance activities/initiatives/programs/missions of the MoHFW, Government of India, the Centre shall carry out activities listed below within the framework of its overall goals. The specific aims and objectives would be:

a. Management of the National Health Portal (NHP) with an objective to provide authenticated health information to citizens of the country, including students, healthcare professionals and researchers

b. To be the Secretariat for the proposed 'National e-Health Authority (NeHA)' (a statutory body for promotion, adoption and regulation of eHealth Standards in India).

c. To establish and manage the 'Integrated Digital Health Information Platform (IHIP)' proposed to be set up covering Public Health, Hospital Information System, Drug Supply Chain, Government Resource Planning and Citizen's Portal for roll-out of a nationwide health IT system to support seamless transfer of data across all health applications, across all healthcare providers – public (states or centre) and private.
d. To serve in an additional capacity to the Ministry of Health and Family Welfare, Ministry of AYUSH and other such nodal agencies concerned with public for dissemination of Health Information through IT/ICT throughout India, as may be decided by MoHFW, Governing Body and the government.
e. To promote and support schemes, programs, projects and initiatives of government of India / state governments for creating awareness and information on health issues amongst people at large.
f. To promote education, consultancy and trainings in health informatics.
g. To produce authentic health information by itself or through partnership programs with WHO, CDC and other national and International universities, NGOs and institutes.
h. To create NCHI as a virtual anchor center to which independent groups from other institutions could connect dynamically as in a shared entity. NCHI will support centres in other institutions in the country in the area of health informatics, eHealth and mHealth.
i. To provide a platform for active interaction among healthcare providers, government officials and institutions both nationally and internationally to work on the area of Information technology and health sciences, and to undertake analysis of Health

Informatics applications. The Centre will organize initiatives, inter alia, national and international seminars and symposia, and will invite national and international experts to participate in these discussions for knowledge generation, dissemination and capacity building within and outside the country.

j. To proactively seek resources in support of the NCHI mission from government, foundations, industry, and philanthropic sources both nationally and internationally.

4.9 National Identification Number to Health Facilities of India (NIN-to-HFI)

The MoHFW has initiated a process for generating National Identification Number for all Health Facilities of India (NIN-2-HFI). NIN will be random but unique 10-digit number within India. In order to identify the geographical location of the health facility, attributes like state, district, taluka, village codes based on MDDS (Meta Data and data Standards) will be attached to NIN initially. More attributes as per requirements can be added as and when such need arises.

The CHI has developed the NIN Web Portal to generate NIN-to-HFI. End-users will be able to confirm by giving NIN through central database and will confirm its available attributes, if found correct. This site has been developed to confirm and verify the existence of the facility.

Since NIN will be permanent unique 10-digit number, verification of health facilities and their attributes is essential. Software has been facilitated to verify the base data. Once base data is verified, NIN will be permanent for that Health Facility and all the Health applications will use NIN in their databases to ensure inter-operability among applications.

This is an ongoing process to allot **a unique, permanent id number** to all the healthcare facilities in India (public/private/individual). It has begun with the public facilities in all the states and UTs that re now being verified. Soon it will be open to all. This may be counted as the Aadhaar number for facilities: http://nin.nhp.gov.in/login.php

One facility (whether public - e.g., AIIMS, New Delhi or a private corporate hospital or any small clinic or a single clinic with an individual practitioner practising will have this single id). The number will be permanent and unique and even if the facility ceases to exist, the number will remain forever.

4.10 Integrated Health Information Platform (IHIP)

An Integrated Health Information Platform (IHIP) is being setup by the CHI. The primary objective of IHIP is to enable the creation of standards compliant Electronic Health Records (EHRs) of the citizens on a pan-India basis along with the integration and interoperability of the EHRs through a comprehensive Health Information Exchange (HIE) as part of this centralized accessible platform. IHIP is envisaged to enable better continuity of care, secure and confidential health data/records management, better diagnosis of diseases, reduction in patient re-visits and even prevention of medical errors, better affordability, optimal

information exchange to support better health outcome, better decision support system, and thus eventually facilitating improvement in the reforms of treatment and care of public health at National-Level.

IHIP is proposed to encompass various components like eHealth applications, eHealth data and eHealth infrastructure. Business model for IHIP has been envisaged on the basis of a set of guiding principles - asset light platform, hiring infrastructure-as-a-service, offering application-as-a-service, cafeteria model of service offering on payment basis, and attaining financial sustainability in due course.

The major features are described below.

- For effective adoption of ICT in Indian healthcare – aligned with health sector goals under Digital India Program – need for integration of and interoperability amongst various Health IT systems and creation of electronic health records (EHRs) of citizens along with pan-India exchange has emerged critical. Most of the patient records have a decentralized storage and gets trapped in multiple silos such as primary care, specialist, hospitals, pharmacy, home health care. Keeping these issues in view, MoHFW has decided to establish an "Integrated Health Information Platform (IHIP)".
- IHIP is envisaged to work in the direction of enabling creation of the electronic health records (EHRs) of citizens and making EHRs available nationwide (through exchange mechanism) with the help of a centralized accessible platform. This would facilitate continuity of care, confidential and secure health data/records management, better affordability, optimal information exchange to support better health outcome, better decision support system, fewer redundancies and medical errors, low data redundancy, big data analytics. A framework and mechanism for unique identification for patients, healthcare providers/organizations and medical procedures would be incorporated so as interoperability (and thence longitudinal aggregation of electronic medical records) is attained amongst different Health IT Systems.
- IHIP is proposed to encompass various components like eHealth applications, eHealth data and eHealth infrastructure. Business model for IHIP has been envisaged on the basis of a set of guiding principles – asset light platform, hiring infrastructure-as-a-service, offering application-as-a-service, cafeteria model of service offering on payment basis, and attaining financial sustainability in due course.
- For eHealth applications – Healthcare Management, EMR, EHR – on IHIP, tried and tested open source solutions offered by third parties (both public and private IT vendors) and complying with EHR Standards (notified by MoHFW in 2013) and other eGovernance Standards (notified by Department of Electronics and Information Technology-DeitY) would be hosted on IHIP. Various developers including innovative start-ups can host their standards compliant applications/solution-suites on IHIP after due process of evaluation by the Ministry. Users can use the applications taking a "Cafeteria Approach" *i.e*. to choose application from available options as per their need on "pay per use" basis. Detailing of envisaged business model for IHIP will be done at the stage of Request for Proposal (RFP). Individual hospitals and healthcare facilities/professionals will have to put in the required infrastructure – terminals, peripheral hardware – in their premises in order to access and use IHIP.

- Sustainability of IHIP is a critical aspect to be addressed properly. For ensuring sustainability, IHIP is planned to explore various possible revenue sources including from health information exchange platform like real-time data services to different healthcare providers, asynchronous data analytics /customized reports for health care analytics organizations. However, in short-to-medium term, funding assistance from the government may be provided, till it achieves a critical mass.
- The various regulatory aspects like privacy, security, access, disclosure, exchange. would be taken care of by National eHealth Authority (NeHA) proposed to be set up by MoHFW. NeHA would also regulate other specifics like what information to be shared, within what timeline the information should be shared

The proposed Integrated Health Information Platform (IHIP) will only be a Platform that will host multiple Standards-compliant modules. The Health Information Exchange planned there is the (Central) Repository.

- Essentially anything and everything that is compliant to any of the EHR Standards recommended by the MoHFW will be hosted through the platform.
- In other words, they could represent CIS, LIS, RIS, HIS or even simple ADT modules - the minimum requirement is the adherence to any of the relevant mandated standards.
- The purpose to develop the IHIP is to facilitate the exchange of health / clinical information among all sorts of healthcare providers, as well as for the purpose of public health / policy making.
- For all practical purposes, the billing by the provider would not be required for the exchange of health information.
- Of course the payors - whether individuals, government or insurance companies, will be interested in those.
- As of now, the IHIP is being developed by the Government to encourage and facilitate exchange of health information and not to make any business.
- The private players, if they host their standards-compliant software for free use, can get their business from customizing the applications to the needs of the user clients.
- However, this is not a panacea for all health problems in India.
- There would be a strong and continuing need for awareness and training.

Also, end users – patients – will have to demand. Bluetooth technology is being used by remote villages in India where there is no electricity and hardly any literacy. People find it useful for exchanging pictures, songs and videos. The day the patients realize the potential of inter-operable health records, the demand will come.

There are a host of other issues - ABCD of health before "e". The social determinants of health, ***viz***., water, sanitation, nutrition, hygiene, along with education and awareness (Knowledge, Attitude and Practice) - all have to be in place before we can hope for a "Swasth Bharat" (Healthy India).

- The entire purpose of the IHIP is to develop an ecosystem to facilitate EHR-Standards compliant exchange of health information throughout India.

- Through the health information exchange, clinical information can be shared with the health information repository.
- If all the healthcare providers are storing / sending health information in EHR-Standards compliant formats, they can be directly interacting with the repository.
- If not, instead of trying to spend a lot of time and effort in developing ***de-novo*** EHR-Standards compliant systems, they can use the ***interface engines (available through the IHIP)*** that will provide **conversion** of health information non-compliant with the EHR standards to EHR-Standards compliant formats.

Also there will be ***EHR-Standards compliant (***ADT/clinical/other***) modules, available through the IHIP***, to pick and choose from, if anyone desires to use those templates for developing their own EHR-Standards compliant systems.

The government of India is keen to ensure smooth adoption of eHealth in India but cannot practically dictate everyone to first become EHR-Standards compliant before exchanging any health information. An age old adage says that the journey of a thousand miles begins with a single step.

Something as ambitious as a "True (Real!) Lifetime EHR for every Indian" is a tall order and certainly something that should be aimed at. However, the timeline for that may not be small.

- **Advantages**

Having a centre of excellence for carrying out well coordinated eHealth activities in India will be a good idea. This will enable the smooth adoption of eHealth / Digital Health (including mHealth and Tele-Health) throughout India.

Health informatics is an evolving academic discipline in India. The formation of the National eHealth / Digital Health Authority and its coming out with a coherent and robust strategy will go a long way in establishing and expanding the career prospects in this domain in India.

- **Disadvantages**

For making end users adopt eHealth, especially for the clinicians, requires a lot of change management, including clinical transformation or reengineering the workflows. For managing the “people” component of this change, well thought out capacity building programs will be necessary. Unless there is ease of use, value proposition, as well as incentive / disincentives, mass adoption of eHealth may not be feasible.

- **Limitations**

Health being a state subject in India, some states are way ahead while others are far behind.

- **Perspectives**

Scaling up is the biggest challenge in embracing eHealth for 1.3 Billion population.
The adoption of eHealth throughout India will require a robust **National eHealth Strategy / Policy (NeHS/P)**, in consultation with all the stakeholders.

Once the **NeHS/P** is in place, through either the MoHFW or NeHA, the short-term, mid-term and long-term goals / deliverables will become clear.

1. The IHIP will facilitate an inter-operable exchange of health information that will be the basis of a lifetime EHR. It will neither happen overnight nor from scratch.
2. Health care providers will benefit if they can draw upon information from the previous / ongoing health information of their current patient.
3. It will help Insurers because more health / illness data will be available in an interoperable format.

4.11 Conclusions

The evolution of the Centre for Health Informatics (CHI), designing and developing the National Health Portal (NHP) of India, into the National Centre for Health Informatics (NCHI), coordinating all the eHealth activities in India has indeed been a great learning experience. Sharing the insights may enable other developing countries to fast track their progression towards adopting eHealth.

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5 Challenges in Implementing Electronic Medical Records

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5.1 Electronic Medical Record (EMR) as a technology based solution intervention has been prevalent in mature markets such as the US for several years now. Digitization of patient records is an accepted industry practice that hospital chains in mature markets, with multi-location and multi-specialty operations are now carrying out. This has increased effectiveness and efficiency in overall operations. Literature mentions benefits ranging from tracing longitudinal patient history, ability to effectively manage patient care continuum to significant savings in maintaining patient records for continued healthcare.

In developing nations such as India, the EMR is an emerging phenomenon. Given the nascent nature of technology adoption and maturity of processes, hospitals are still working on frameworks, to quantify benefits of technology investments and re-engineering of processes brought about by digitization. Hospitals are seeking relevant best practices and success criteria to guide them through their roll-out plans and managing the change in their respective hospitals and health systems

While, every hospital has its uniqueness in terms of a business process, there are a few standard issues that always need to be factored, to ensure successful implementation. The techniques used in planning should bear in mind, the impact that they could have on operational, clinical and financial excellence of the hospital enterprise. The goal of the EMR implementation is to maximize efficiency and minimize cost of implementation.

5.2 Understanding the Healthcare IT

Health Information Technology (HIT) is "the application of information processing involving both computer hardware and software, that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (BRAILER& THOMPSON, 2004). Technology is a generalized concept that deals with a broad usage and knowledge of tools and crafts, and how it affects a targeted audience's ability to control and adapt to the environment. "Technology" can refer to material objects of use to humanity, such as machines, hardware, but can also encompass broader themes, including systems, methods of organization, and techniques. For HIT, technology includes computers and communications attributes that can be networked to build systems for moving health information. Informatics is another integral aspect of HIT.

Informatics refers to the science of information, the practice of information processing, and the engineering of information systems. Informatics underlies the academic investigation and practitioner application of computing and communications technology to healthcare, health

education, and biomedical research. Health informatics refers to the intersection of information science, computer science, and health care. Health informatics describes the use and sharing of information within the healthcare industry with contributions from computer science, mathematics, and psychology. It deals with the resources, devices, and methods required for optimizing the acquisition, storage, retrieval, and use of information in health and biomedicine. Health informatics tools include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems. Medical informatics, nursing informatics, public health informatics, and pharmacy informatics are sub-disciplines that inform health informatics from different disciplinary perspectives. The processes and people of concern or study are the main variables.

5.3 Types of Technology

Adoption of technology can be classified into applications such as

- Electronic medical records (EMR),
- Clinical decision support (CDS), and
- Computerized physician order entry (CPOE).

Further advanced applications include

- Dispensing to include bar-coding at medication dispensing (BarD),
- Robot for medication dispensing and
- Automated dispensing machines (ADM).
- Applications for administration to include electronic medication administration records (EMAR)
- Bar-coding at medication administration (BarA).

5.4 The Need for EMRs

An Electronic Health Record (EHR) is also known as the Electronic Medical Record (EMR). EMRs can reduce several types of errors, such as those related to prescription drugs, manage better preventive care, and ensuring adherence to best evidence based clinical practices while ordering tests and procedures.. Clinical guidelines for disease management have a demonstrated benefit when accessible within the electronic record during the process of treating the patient. Advances in health informatics and widespread adoption of interoperable electronic health records promise access to a patient's records at any health care site. Despite barriers to adopting an EHR system, like training, costs and complexity, the adoption rate is seeing a steady growth.

5.5 Computerized Provider (Physician) Order Entry (CPOE)

Errors caused during medication prescription, prescription writing and medication administration are the largest identified source of preventable errors in hospitals. A 2006 report by the Institute of Medicine estimated that a hospitalized patient is exposed to a medication error each day of his or her stay. Computerized provider order entry (CPOE), formerly called Computer physician order entry, can reduce total medication error rates by 80%, and adverse (serious with harm to patient) errors by 55%.A 2004 survey by Leapfrog found that 16% of US clinics, hospitals and medical practices are expected to be utilizing CPOE within 2 years.

In addition to electronic prescribing, a standardized bar code system for dispensing drugs could prevent a quarter of drug errors. Consumer information about the risks of the drugs and improved drug packaging (clear labels, avoiding similar drug names and dosage reminders) are other error-proofing measures. Despite ample evidence of the potential to reduce medication errors, competing systems of barcoding and electronic prescribing have slowed adoption of this technology in the United States. Concerns with interoperability and compliance with future national standards add to the problem. , For the small-practice physician, utilizing CPOE requires a major change in practice work flow and an additional investment of time. Many physicians are not full-time hospital staff; entering orders for their hospitalized patients means taking time away from scheduled patients.

Estimated Annual Benefits from Inpatient Computerized Physician Order Entry Systems, After Full Adoption

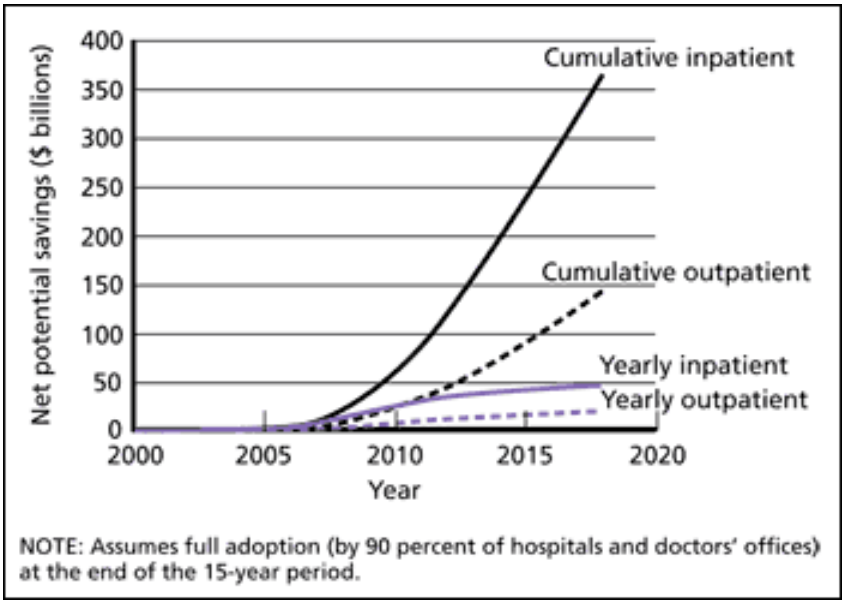


Figure 5.1 RAND Healthcare: Health Information Technology: Can HIT Lower Costs and Improve Quality

Retrieved on July 8, 2006

Handwritten reports or notes, manual order entry, non-standard abbreviations and poor legibility lead to substantial errors and injuries, according to the Institute of Medicine (2000) report. The follow-up IOM (2004) report "Crossing *the quality chasm: A new health system for the 21st century"*, advised rapid adoption of electronic patient records, electronic medication ordering, with computer- and internet-based information systems to support clinical decisions. However, many system implementations have experienced costly failures. Such failures are commonly attributed to immature planning of the implementation, underestimation of complexity, poor mapping of workflows and its impact due the implementation of CPOE, insufficient training g and lack of management sponsorship.

EMR and EHRs have a subtle difference in their definition and purpose. In general, an EMR is a specific recording/episode of an encounter and is case or purpose specific Care, while an EHR is an aggregation of EMRs and is usually life-long.

Benefits of an EMR include:

- Reduced healthcare costs
- Empowering stakeholders to be able to deliver right treatment at the right time
- Promote practice of evidence-based medicine
- Accelerate research and building effective medical practices
- Ease in maintaining health information of patients
- With proper backup policies increase lifespan of health records of individuals, that is from cradle to grave
- Safety with access, audit and authorization control mechanisms
- Faster search and updates on patient specific clinical information

5.6 The Healthcare IT Landscape in US

The Institute of Medicine's call for the use of electronic prescribing systems in all healthcare organizations by 2010 heightened the urgency to accelerate United States hospitals' adoption of computerized physician order entry (CPOE) systems. In 2004, President Bush signed an Executive Order titled the President's Health Information Technology Plan, which established a ten-year plan to develop and implement electronic medical record systems across the US to improve efficiency and safety of care. The American Recovery and Reinvestment Act (ARRA), signed into law in 2009 under the Obama Administration, has provided approximately $*19 billion in incentives for hospitals to shift from paper to electronic medical records.* The American Recovery and Reinvestment Act has set aside $2 billion which will go towards programs developed by the National Coordinator and Secretary to help healthcare providers implement HIT and provide technical assistance through various regional centers. The other $17 billion dollars in incentives comes from Medicare and Medicaid funding for those who adopt HIT before 2015. Healthcare providers who implement electronic records can receive up to $44,000 over four years in Medicare funding and $63,750 over six years in Medicaid funds. The sooner that healthcare provider adopts the system, the more funding they receive. Those who do not adopt electronic health record systems before 2015 do not receive any federal funding.

While electronic health records have potentially many advantages in terms of providing efficient and safe care, recent reports have brought to light some challenges with implementing electronic health records. The most immediate barriers for widespread adoption of this technology have been the high initial cost of implementing the new technology and the time required for doctors to train and adapt to the new system. There have also been suspected cases of fraudulent billing, where hospitals inflate their billings to Medicare. Given that healthcare providers have not reached the deadline (2015) for adopting electronic health records, it is unclear what effects this policy will have long term.

5.7 The Healthcare IT Landscape in India

The Healthcare sector in India has been seeing a very vibrant level of activity. It is estimated to reach a market size of USD 280 billion by 2020 based on the Nov 2011 report by India

Brand Equity Foundation. Despite this the funding in this sector is not matching the projections of growth.

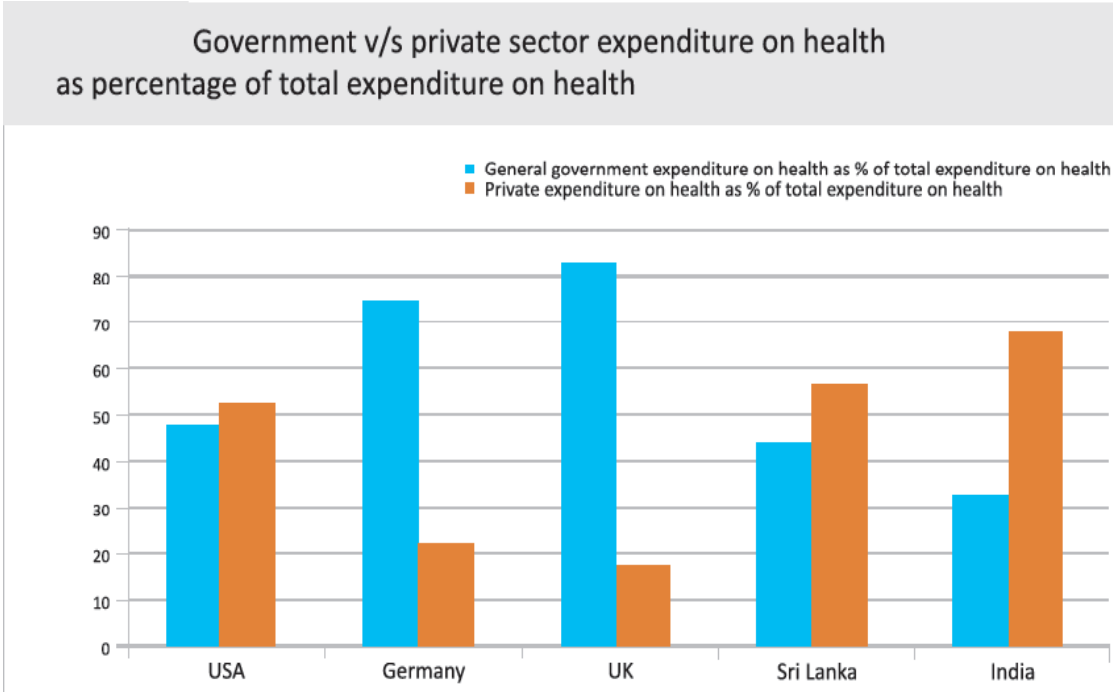


Figure 5.2 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

The penetration of insurance sector in India is growing and the projections are beneficial to the overall economy and citizen well-being. It is amply clear that the private sector is moving more aggressively than the government.

Health Care sector in India has witnessed significant growth during the last few years, both in quality and capacity. The relatively lower cost of health care, as compared to developed countries, coupled with international quality, has positioned India as a major destination for health care services. The private sector has also initiated massive investments in various facets of healthcare. This is expected to position health care as one of the largest service sectors and a significant contributor to the GDP. As the health sector is poised for major growth in next decade, the sheer size of healthcare sector in the country will necessitate extensive use of information and communication technology (ICT) infrastructure, services and databases for policy planning and implementation. Such a framework would require services based on inter-operable and sharable technology, standards utilization, connecting various institutions and service providers.

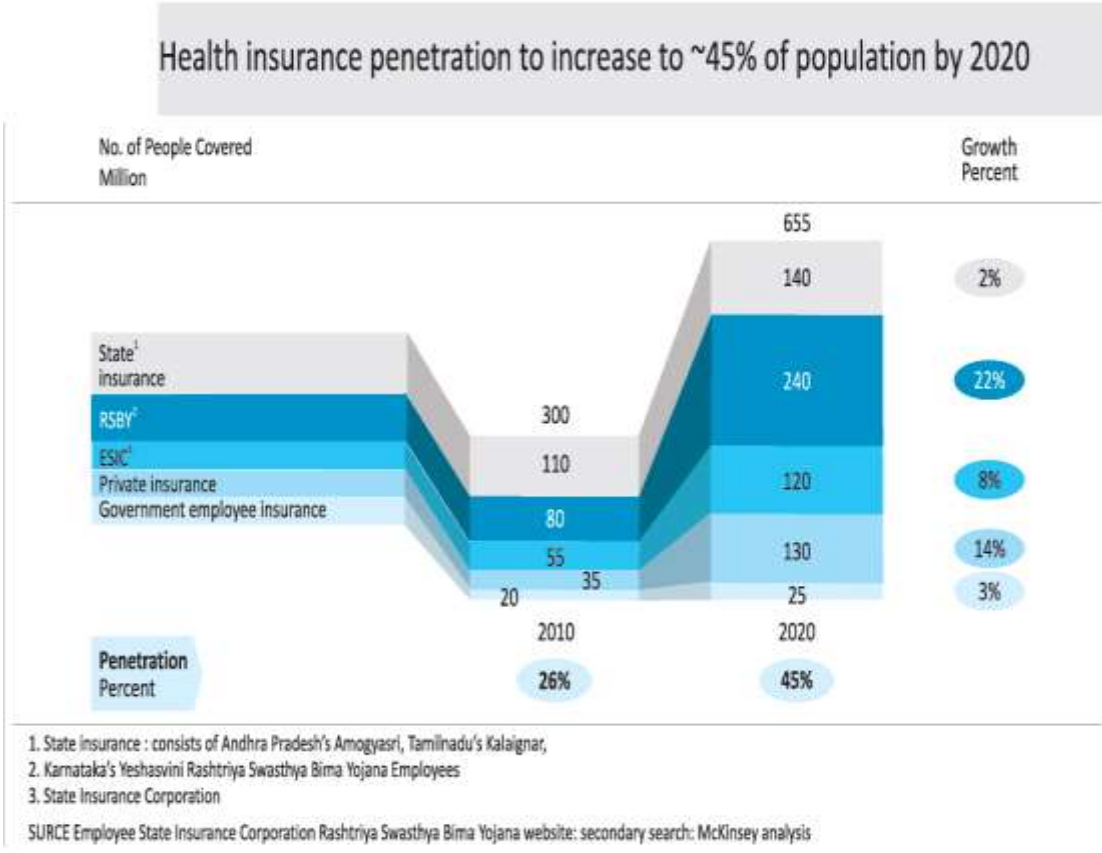


Figure 5.3 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

The efforts spear-headed by the Ministry of health and family Welfare on bringing out EMR/EHR standards for India (august 2014) , the move towards the constitution of a National eHealth Authority (2016) are clearly path breaking and positive signs that are bound to help the Indian Health IT industry leapfrog to becoming a positive contributor to the Indian economy.

5.8 EMRAM model for EMR adoption

The major challenge surrounding the aggressive adoption of electronic medical records (EMRs) is the ability of these systems to produce measureable benefits. Researchers have aggregated the benefits described in these individual accounts to argue that a complete EMR should produce very substantial benefits for individual hospitals and the healthcare system as a whole. By guiding clinicians to safer, more efficient, more effective care, these systems will arguably drive most of the potential benefits of EMRs.

As shown in figure below, relatively few US hospitals have reached Stage 6 and 7 of the EMR Adoption Model (EMRAM) [SM] scale, in which CDS systems have greater ability to drive benefits. Almost all of those hospitals reached Stage 6 or 7 in the last few years.

Table 5.1 EMR Adoption Model (EMRAM)[SM] scale

Stage	Cumulative Capabilities
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), full R-PACS
Stage 5	Closed loop medication administration
Stage 4	CPOE, Clinical Decision Support (clinical protocols)
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed
Stage 0	All Three Ancillaries Not Installed

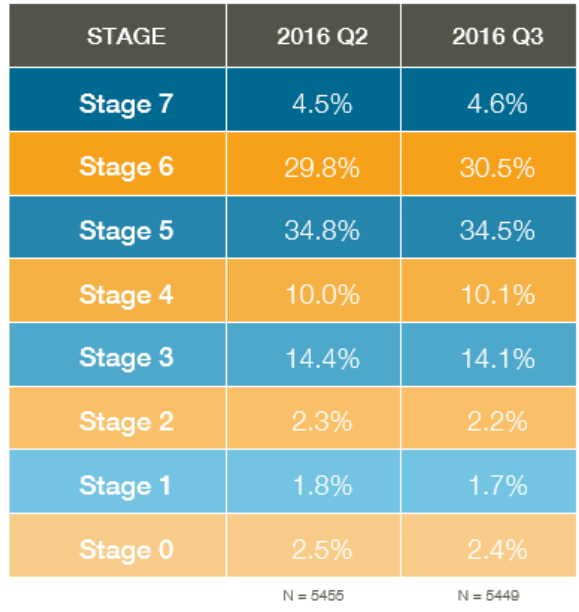


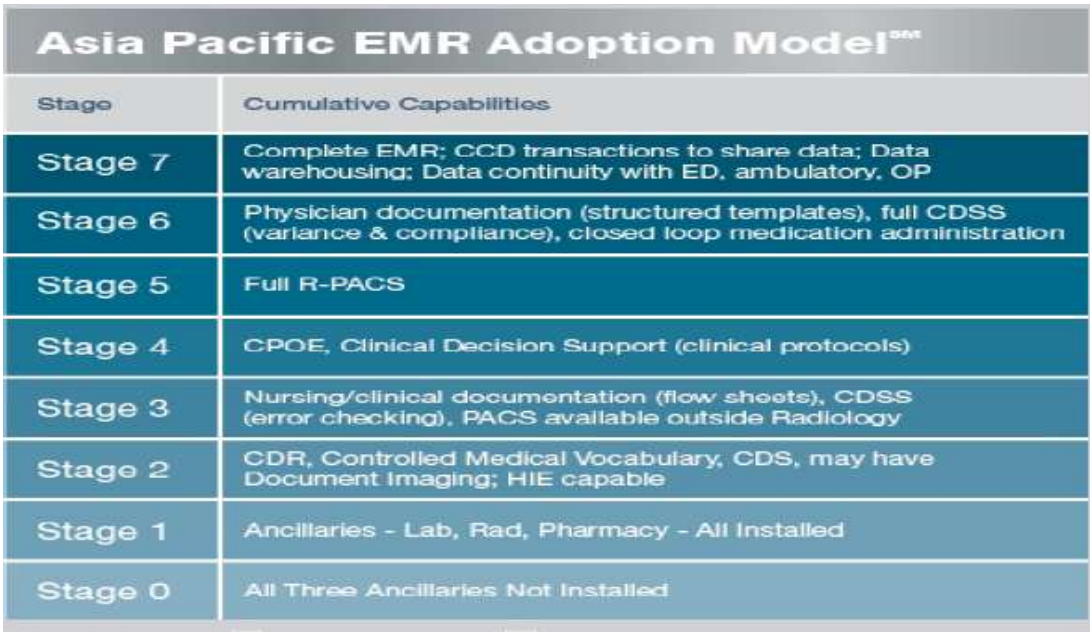
Figure 5.4 United States EMR Adoption Model

Source: Adopted from HIMSS Analytics

5.9 Description of EMRAM Stages

EMRAM Score provides hospitals and governments with a roadmap for implementing technologies that enable a fully realized EMR that improves patient care through clinical decision support rules, alerts, and protocols at the point of care. International benchmark

consisting of 8 (0-7) stages towards achieving a paperless environment and improving the quality of care through the use of technology .All technologies in a stage must be accomplished before the hospital can move up a level in the model.



Asia Pacific EMR Adoption Model℠	
Stage	Cumulative Capabilities
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), closed loop medication administration
Stage 5	Full R-PACS
Stage 4	CPOE, Clinical Decision Support (clinical protocols)
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed
Stage 0	All Three Ancillaries Not Installed

Figure 5.5 HIMSS Analytics Asia Pacific EMR Adoption Model

- **Stage 0:** Some clinical automation may be present, but all three of the major ancillary department systems for laboratory, pharmacy, and radiology are not implemented. Systems that are in place are departmentally focused, not patient centered focused via a common patient record.
- **Stage 1:** All three of the major ancillary clinical systems (pharmacy, laboratory, radiology) are live and operational. Again, these are departmentally focused, not patient centered focused via a common patient record.
- **Stage 2:** Major ancillary clinical systems feed orders and results to a CDR that provides physician access for retrieving and reviewing results in a patient centric record. The CDR contains a controlled medical vocabulary, and the clinical decision support/rules engine for rudimentary conflict checking. Information from document imaging systems may be linked to the CDR at this stage, and initial linkages to health information exchanges (HIEs) may be accomplished at this stage for sharing diagnostic patient information. The first level of clinical decision support is implemented to conduct error checking with order entry from ancillary systems (i.e., drug/drug, drug/food, drug/lab conflict checking normally found in the pharmacy, or duplicate laboratory order checking found in lab) by this stage.
- **Stage 3:** Clinical documentation (e.g. vital signs, flow sheets) is required; nursing notes, care plan charting, and the electronic medication administration record (eMAR) system are scored with extra points, and are implemented and integrated with the CDR for at least one service or one unit in the hospital. Some level of medical image

access from radiology picture archive and communication systems (RPACS) is available for access by physicians via the organization's intranet or other secure networks outside of the radiology department confines.

- **Stage 4:** Computerized Practitioner/Physician Order Entry (CPOE) for use by any physician is added to the nursing and CDR environment along with the second level of clinical decision support capabilities related to evidence based medicine protocols. If one inpatient service area has implemented CPOE and completed the previous stages, then this stage has been achieved.
- **Stage 5:** The closed loop medication administration environment is fully implemented in at least one patient care service area. The data flows of the CPOE, pharmacy, and the electronic medication administration record (eMAR) applications are tightly coupled and integrated with bar coding technology (or RFID technology) for the nurse (nurses may be identified via their logins to bar code scanning equipment), patient and medication to support the five rights of medication administration, thereby maximizing medication administration point of care patient safety processes.
- **Stage 6:** Full physician documentation/charting (using structured templates) is implemented for use by any physician that generates discrete data for at least one patient care service area. Level three of clinical decision support provides guidance for clinician activities related to protocols and outcomes in the form of variance and compliance alerts. A full complement of radiology PACS systems provides medical images to physicians via an intranet and displaces all film-based images for radiology services.
- **Stage 7:** The hospital no longer uses paper charts to deliver and manage patient care and has a mixture of discrete data, document images, and medical images within its EMR environment. Clinical data warehouses are being used to analyze patterns of clinical data to improve quality of care and patient safety. Clinical information can be readily shared via standardized electronic transactions (i.e. Continuity of Care Record -CCR and Continuity of Care Document - CCD) with all entities within a integrated delivery system, or a health information exchange (i.e., other non-associated hospitals, ambulatory clinics, sub-acute environments, employers, payers and patients in a data sharing environment). There is a continuity of data flows for patients between the inpatient, emergency department, and outpatient or service modalities.

This version of the EMRAM model is also applied to Canadian hospitals. This model has been adapted to score hospitals in Europe, the Middle East, Asia and Australia. The model has also been adapted to score ambulatory facilities (A-EMRAM)

5.10 Perceptions on ROI in the Healthcare Industry

Three Stages of Economic Return

As the implementation of EMR progresses from within a small clinic to across the enterprise, healthcare organizations can expect to experience growing economic returns on their investments. The return on investment (ROI) can be anticipated to build in several stages.

1. The first stage is characterized by operational efficiencies and workflow automation achieved through process re-engineering and faster access to accurate information.

The benefits gained in this stage include reduced overhead costs and professional liability rate reduction.

2. In the second stage, benefits are derived from increased clinic productivity and decision support at the point of care. As more information is entered into the EMR, standard care protocols, order management, and outcomes analyses can be supported. EMR users experience quality improvements, compliance with regulatory requirements, and reduced exposure to risk.
3. In the longer term, investments in EMR can provide healthcare organizations with a distinct competitive advantage. Looking forward, hospitals and health systems anticipate using EMR as a tool to manage the business of delivering care efficiently and cost-effectively, and to provide more responsive care to an increasingly selective consumer.

5.11 Organization-Wide Financial Impact of the EMR

Physicians and health care providers are consistently able to access appropriate clinical information instantly from any of their clinics, as well as any hospital or even from home. As a direct result of implementing the EMR, Hospitals have dramatically reduced their transcription expenses; cut its manpower requirements for medical record maintenance; eliminated the need for medical records space; and generated increased revenues through improved E/M coding.

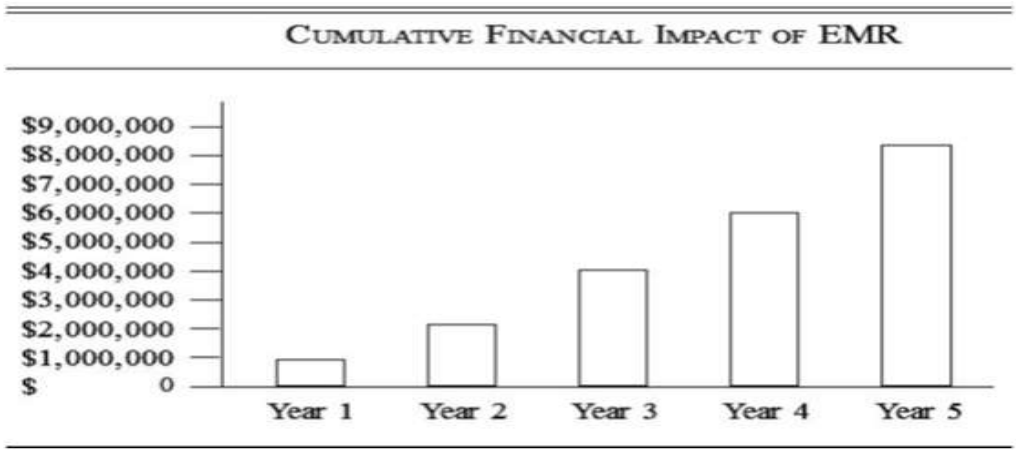


Figure 5.6 The Economic Effect of Implementing an EMR in an Outpatient Clinical Setting Scott Barlow, MBA, Jeffrey Johnson, MD, Jamie Steck, MBA

Decreased Labor and Supply Costs for chart Maintenance

The implementation of the EMR allowed Hospitals to dramatically reduce its dependence on paper records. As a result, the Hospital was able to avoid increases to FTE medical record staffing, even as the patient load rose significantly.

Decreased Physical Space Requirements Due to Paperless Record

Hospitals have downsized their physical space requirements for record storage in existing buildings. Several chart storage rooms are slated to become offices or exam rooms in the near future In addition there will be an incremental revenue that will be generated by the transformation of storage space into revenue-generating areas.

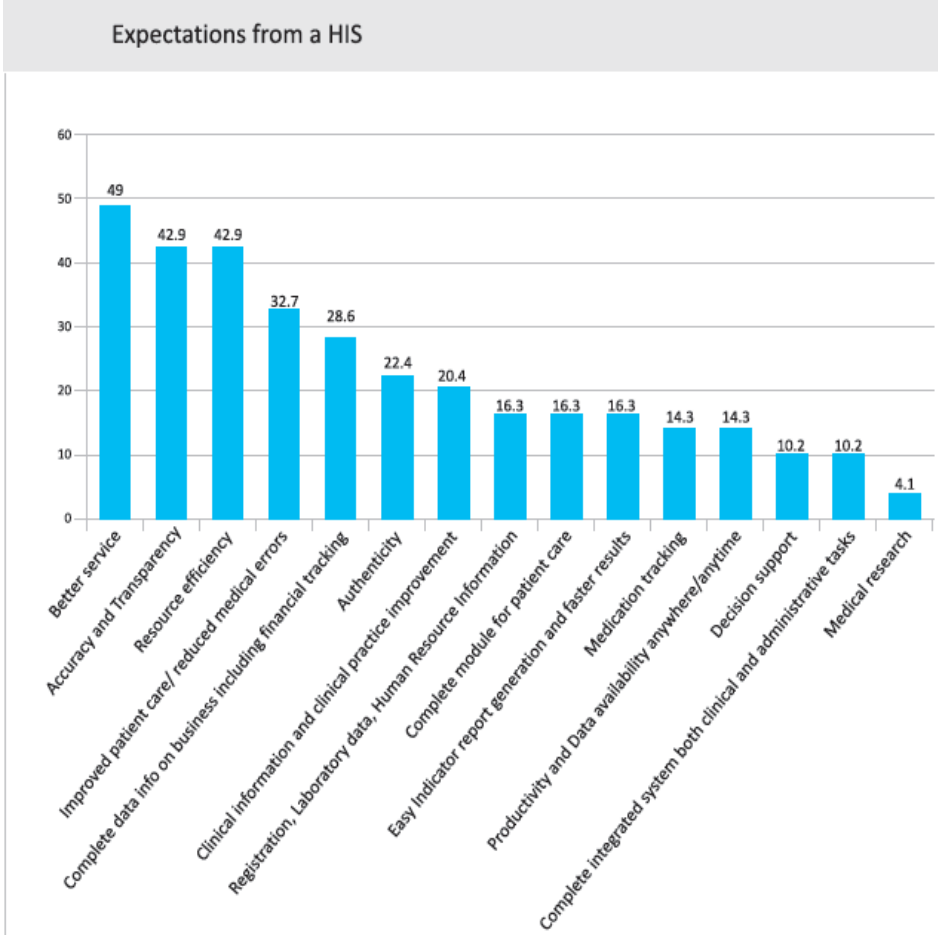


Figure 5.7 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

One of the key components of the system that enables Health care organizations to transition to a completely paperless environment is document imaging, the conversion of paper documents to electronic images. The EMR allows staff to electronically scan into the computer system existing paper charts and other non-automated documents, such as written correspondence. Scanned documents are available to physicians via the EMR instantly – a significant improvement over the old system, which often required up to three weeks for paper documents to make it into a patient's chart.

In the Indian context, the ROI expectation from hospitals does not differ from those in US, Europe or Asia Pacific. The figure below is an illustration of the same based on a survey from HIMSS, India.

5.12 Factors Influencing the Adoption of EMRs

Hospitals can benefit from effectively implementing electronic health records, computerized-physician-order entry systems, and related Health IT standards.

In Canada, a regional health care provider successfully implemented electronic health records and related systems in four large hospitals. Over a period of four years, the hospital system developed standard guidelines for medical procedures and decision support protocols, configured and implemented the new IT system, and rolled it out to the area's four major hospitals, achieving a 90 percent-plus adoption rate by clinicians.

The use of standardized guidelines developed by leading organizations (such as AMA - American Medical Association, ICMR – Indian Council of Medical research) helps to spread the use of best-practice medical procedures, which improve patient outcomes. In cardiac care, for instance, patients treated with the recommended protocols improved faster and spent fewer days in hospitals. The figure 5.8 given below is the result of such initiatives undertaken by Apollo Hospitals Group, India.

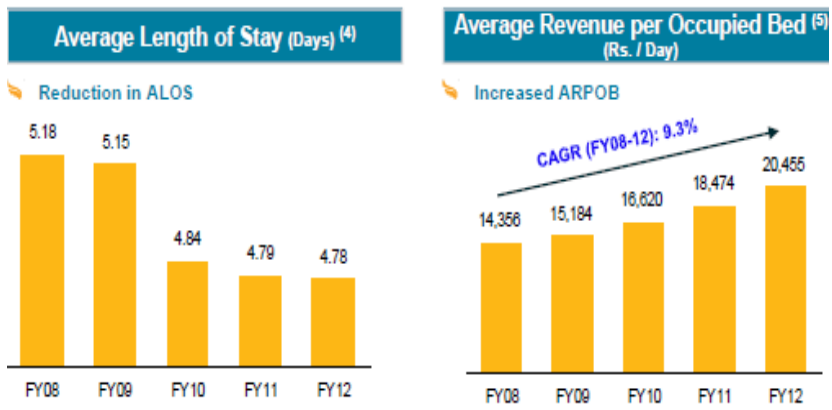


Figure 5.8 The result of such initiatives undertaken by Apollo Hospitals Group

A large US health care provider with about 50 hospitals across multiple states sought to implement an electronic-health-record system that would achieve high acceptance among clinicians. Given that this was more an organizational-change assignment rather than an IT implementation, the team spent substantial time at the outset planning, what processes should be improved, engaging frequently with leaders in the physician community to discuss expectations, and formulating a list of desired changes. To manage complexity, the team piloted the first few rollouts so it could make improvements as it went along. This approach helped the team complete the subsequent implementation in the hospital system as a whole much more quickly than would have been possible without learning from the pilots. Training materials and change management techniques were piloted as well to smooth the transition and encourage adoption. Although the implementation is ongoing, after the first three months

this phased-in approach has already resulted in adoption levels as high as 75 percent for computerized-physician-order-entry systems. Countries such as the United States, United Kingdom and Australia have growing and robust healthcare infrastructures that receive substantial funding and support from its governments. Though significant failures still exist in these systems, there is strong support and motivation to accomplish goals associated with comprehensive development of successful information technology systems. These countries are able to make significant investments in research to develop information systems that would meet the need of their particular healthcare system. This is in sharp contrast to the healthcare infrastructure of many developing countries. For many of these countries the delivery and management of healthcare services alone, comes with many challenges. In many of these countries, implementers of healthcare information technology based solutions are faced with complex challenges such as inadequate funding, lack of resources, weak healthcare infrastructure and computer illiteracy.

Training is considered central to any healthcare delivery system. It is well known that use of computers and IT by medical students will result in more effective medical training. , In several countries cutting edge technologies like 3D simulations, virtual reality and robotics are used for training clinicians. . Absence of innovative IT based training techniques and lack of exposure to advanced concepts further widen the gap between clinicians on the two sides of the divide. Analysis of factors around the adoption of EMRs

In a 2011 study conducted by the Center for Disease Control in the United States, 54% of physicians in office-based practices had adopted EHRs and 46% had not. Differences were observed between physicians who were EHR adopters and non-adopters by age, physician specialty, practice size, and ownership. Generally, physicians under the age of 50 were observed to be more likely to adopt EHR systems. The proportion of physicians who were adopters increased as the size of the practice increased.

The productivity and resource savings often pay back the initial IT investment within two to four years while also producing better health outcomes for patients. It is estimated that total savings across the US provider landscape could be on the order of $40 billion annually. (By comparison, about $1.3 trillion a year is spent on inpatient and outpatient services across the United States and about $80 billion on health care IT.) Achieving such a positive return on investment (ROI), however, requires distinctive change-management skills among hospital leaders, better governance, and sustained engagement from key clinicians.

While most of the developed markets have long encouraged EMR implementation, countries across the globe exhibit various EMR adoption rates. An analysis of hospital EMR adoption rates, projects the Nordics, Spain and Australia to be global leaders in overall EMR implementation in 2013, while France, Germany and Japan are expected to be market laggards with lower rates of adoption. The United States is expected to leapfrog a number of countries in terms of hospital-based EMR adoption by 2013 and exhibits the highest projected growth rate of the nine focus markets.

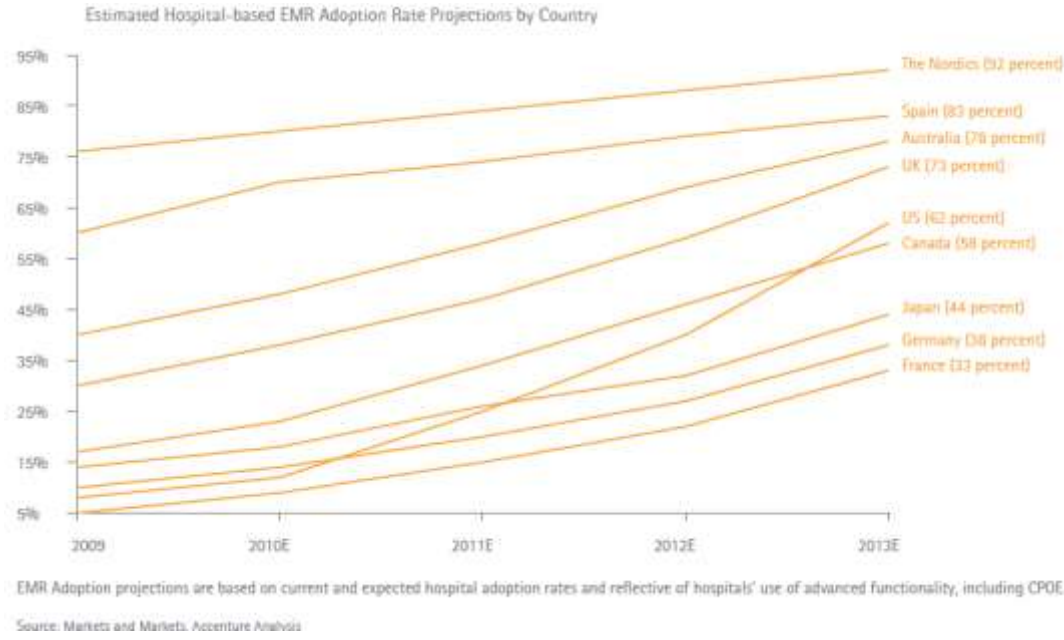


Figure 5.9 Overview of International EMR/EHR Markets: Results from a Survey of Leading HealthCare Companies August 2010

In a study conducted by HIMSS, India the following graph shows the departments taken up for automation in health care institutions and hospitals that are considered mid or large sized in India.

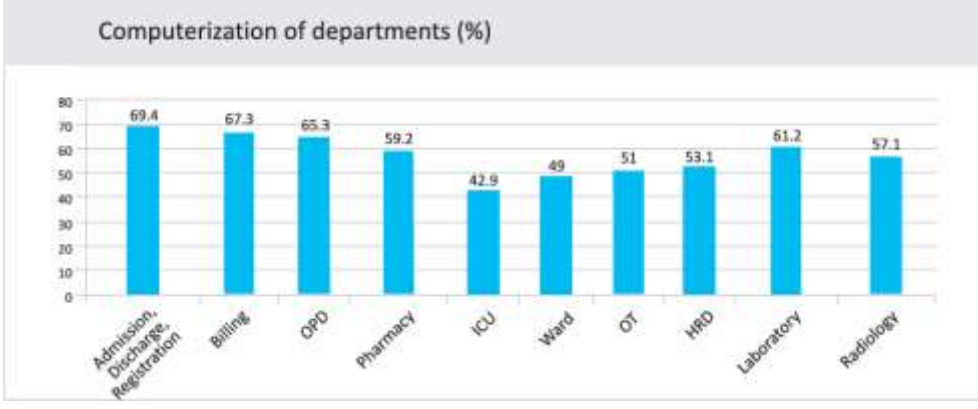


Figure 5.10 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

Graph below shows the extent to which computerization was achieved in comparison to the above graph. This was studied with specific emphasis on Hospital and Clinical processes.

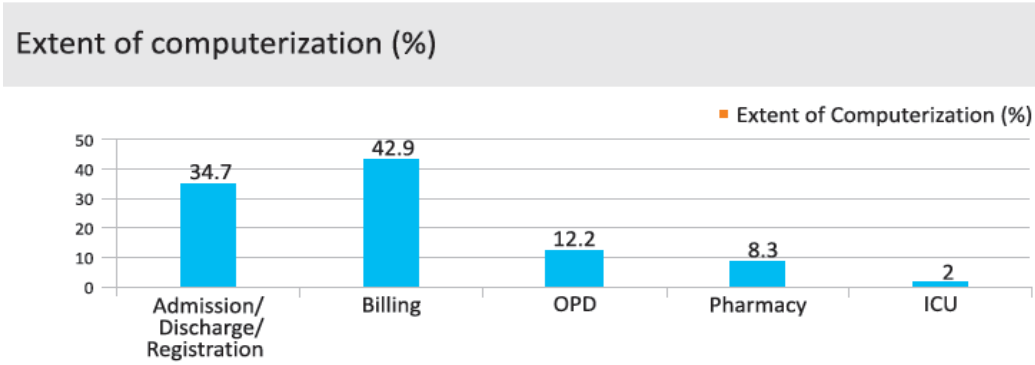


Figure 5.11 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

In terms of the adoption and challenges, the following graph attributes are significant when it comes to managing issues around adoption of healthcare information technology. The most important issues contributing to adverse adoption rates were lack of interest among employees and reluctance to adopt by doctors.

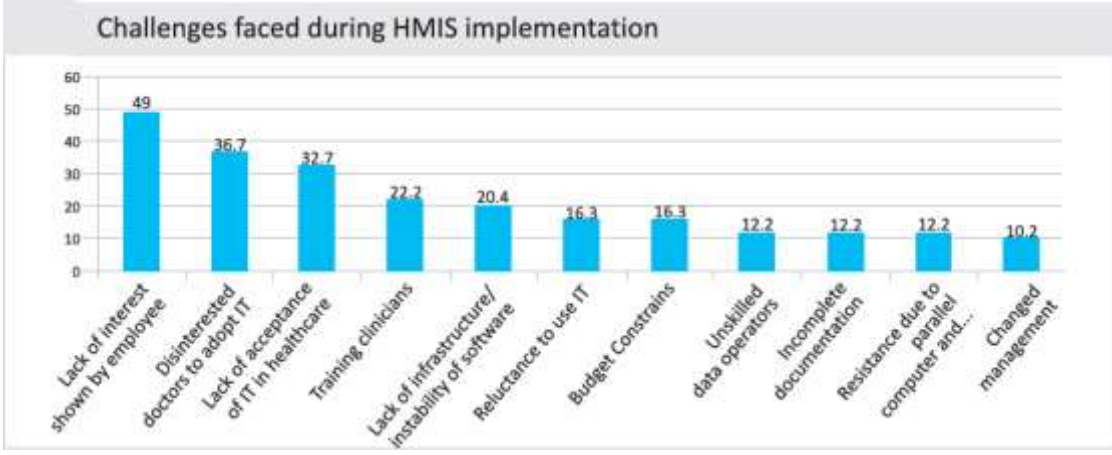


Figure 5.12 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

Critical success factors for managing effective implementation of HMIS is effective and optimized process implementation to suite a computerized organization. Care must be taken around this since, it's not a direct replacement of manual process between a manual and digital enterprise.

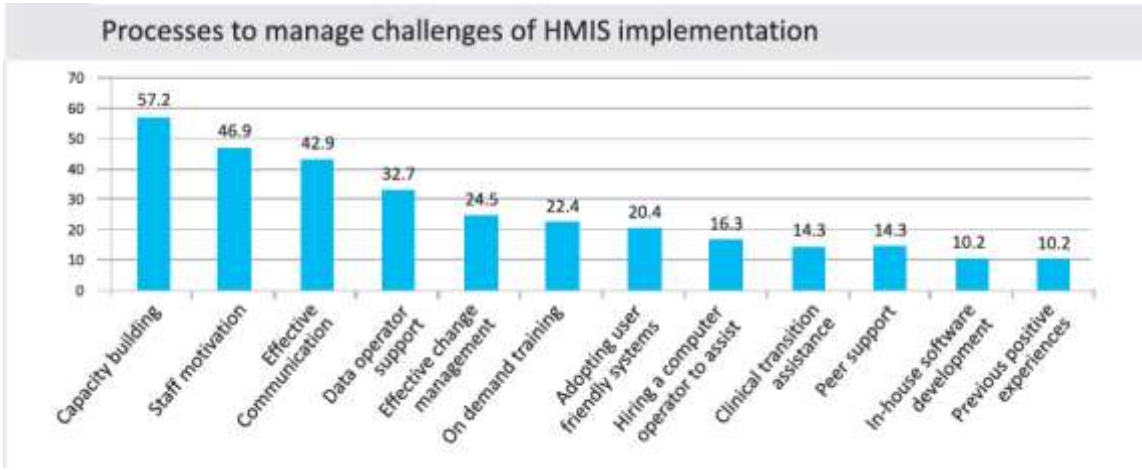


Figure 5.13 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

In addition to process management, it is critical to understand and concentrate on integration of systems. While from a technology perspective, solutions could be different, they have to be aligned and orchestrated in an effective manner such that the clinical and operation workflow is seamless and reduces the complexity of technology barriers (be it users or technology interoperability).

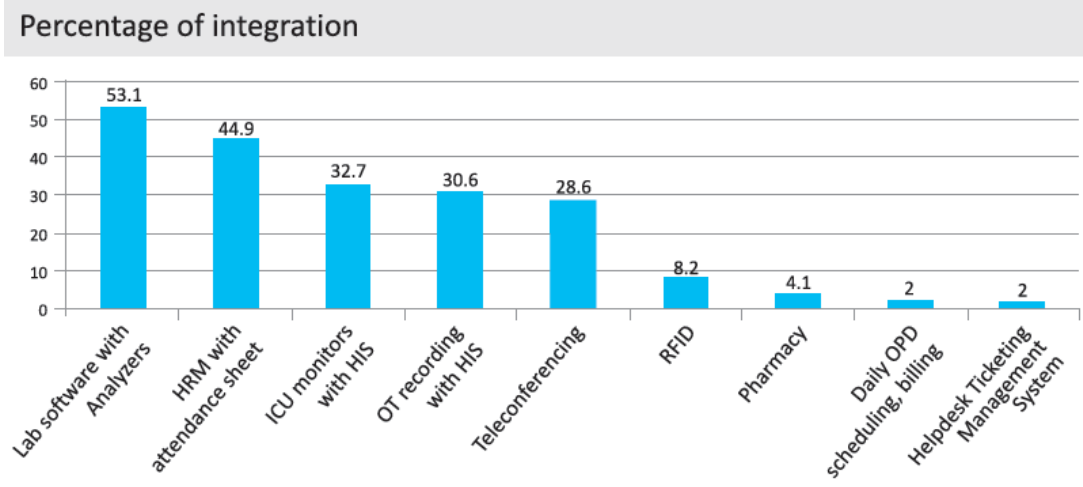


Figure 5.14 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

The above now automatically translate to satisfaction and hence adoption.

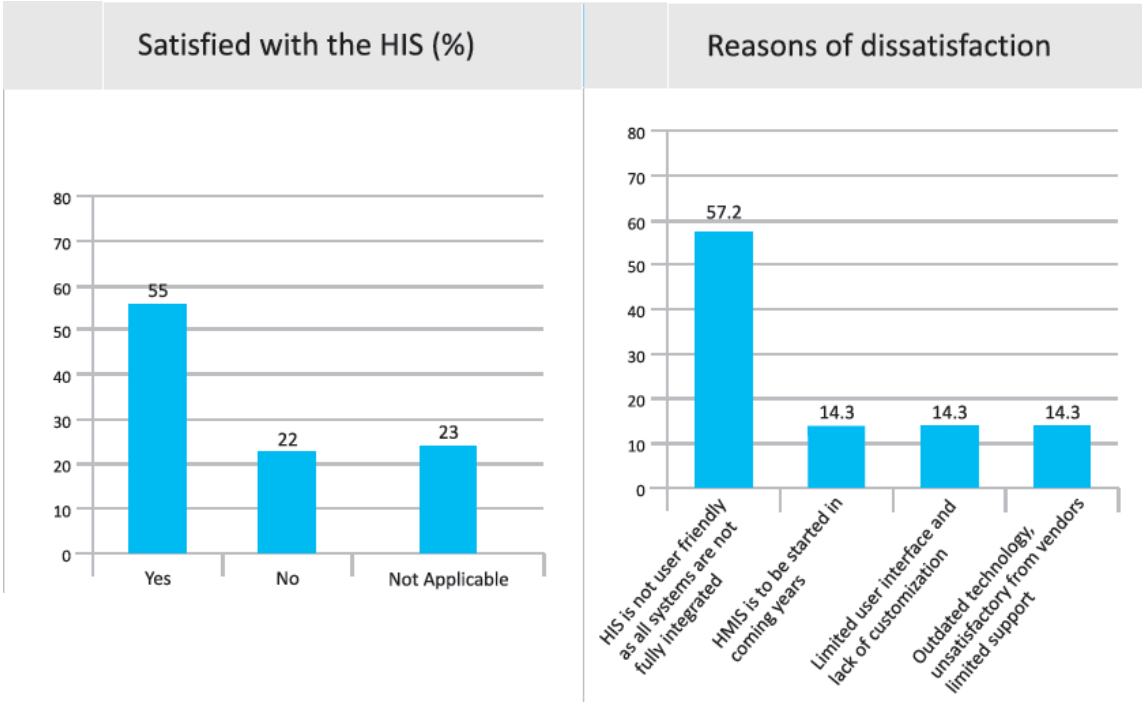


Figure 5.15 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

- ***Success Factors***

Broadly, about three success factors distinguish the best IT implementations among health care providers.

- ***Positive Governance with Real Authority***

Involving key stakeholders, such as clinicians, hospital administrators, senior management and IT teams, early in the IT decision process is critical to ensure buy-in and to inform requirements. To achieve the value at stake, clinicians and administrators will need to change their behavior. In many cases, this is difficult A good technique would be to have highly regarded physicians projected as champions in the process of selecting the IT system and also leading development of guidelines for medical procedures. These evangelists also help the provider engage with the broader physician community. This leads to acceptance during project implementation and adoption later. A steep change in an organization's approach to governance and change management is required., Selection of clinician leaders and champions, creating governing bodies focused on specific topics (such as order set development) confirming decision makers among stakeholders, and training at the point where IT systems interact is imperative.

- ***Simplification of solution design and architecture***

IT applications and platforms, common among providers today, create a significant level of complexity, increased costs, and lengthen implementation schedules. The delays and cost escalation can undermine large-scale health care IT implementations. A simplified

architecture, that eliminates the complexity and reduces the cost of large-scale system implementations, will be a definite critical prerequisite to success.

- ***Methodical planning and execution***

For IT to enable better clinical work flows and medical practices, many elements must come together. The implementation team should address the IT architecture, standards, and changed medical practices in the early planning stages. Implementation should be rolled out in a systematic, modular way, with active tracking of progress and lessons learned. It is important not to underestimate the amount of time and due diligence that go into planning a megaproject. Many US health care providers rolled out their EMR systems in a series of phased pilots across each hospital, an approach that allowed it to capture lessons and use them in subsequent rollouts. A full-time implementation team are established to track progress and provide support and training to physicians throughout the change process. All successful large-scale implementations of health care provider IT systems have used similar sophisticated megaproject-management approaches.

- ***Barriers to implementation of EMRs***

Some of the disadvantages include the startup costs, which can be excessive. However, an EHR can not only reduce costs but also improve quality of care through "better-informed healthcare providers and patients, the elimination of duplicate testing, and better coordination of treatment by more than one healthcare provider". Although providers are concerned with return on investment, it is realized that the "gains from EHRs are more in patient safety and clinical outcome efficiencies rather than financial measures.

Another disadvantage to an EHR is that there is a substantial learning curve Today, clinicians are the primary users of EHRs as opposed to the main users of the past, which where data entry operators. One of the more challenging issues confronting EHRs is the fact that "physicians must be the users of the system, performing data entry (e.g., orders, progress notes) as well as information retrieval, if they are to realize the benefits of interactive on-line decision support" .

Usability can be a major obstacle affecting the implementation of an EHR. Systems must be user friendly; otherwise these systems will not be easily accepted, nor will they be used to their fullest capacity. "While putting down the pen and picking up the mouse involves a cultural shift, clinicians soon realize the benefits of a readily available, organized patient database, enhanced communication among staff, improved risk management, and instantaneous outcome tracking and reporting capabilities"

Confidentiality and security issues are concerns associated with both the paper health record and the EHR. There has been much discussion about this topic and although the patient record must be protected, the patient must also remember that the record has to be accessible to the professionals who use the records to provide medical care. "Laws must not be so stringent as to prohibit access to those with a legitimate right to information".

There are several security technologies available that will help prevent unauthorized access to protected health information. Properly designed and monitored audit trails can enhance user accountability by detecting and recording unauthorized access to confidential

information. System designs must consider how individually identifiable medical information will be protected and also meet regulatory requirements. Whereas stringent security measures should be applied to protect the confidentiality of patient information, it is also in the patient's best interest for the EHR to be accessible for appropriate, legitimate uses by authorized users.

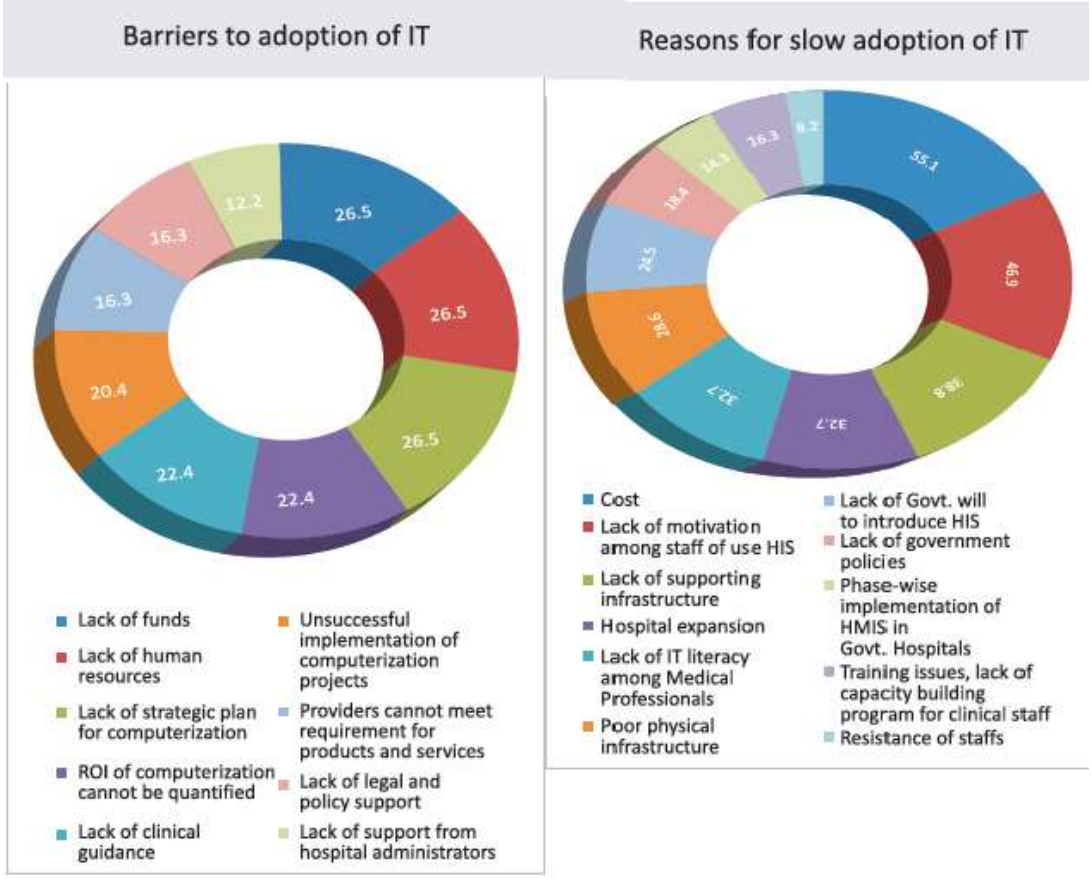


Figure 5.16 State of Healthcare IT in India – HIMSS Asia Pacific India Report 2011-2012

Placement of hardware is an issue and decisions regarding the portability of the equipment must also be considered. Since workflow will change after the implementation of an EHR, decisions must be made to determine who enters the data and documentation forms must be revised in order to accommodate the changes.

Another obstacle in the implementation of an EHR is the "lack of standardized terminology, system architecture, and indexing. For an EHR to be shared, there be a standard language and unique health identifier. Today there are as many vendors as software applications. As the ultimate goal of an EHR is to have the ability to share the record with other facilities and physicians worldwide, a unique health identifier is required. Accomplishing this task has been both slow and daunting.

- ***Optimizing the use of labor***

Many hospitals continue to rely on manual charting, paper records, and outdated software to manage bed counts, schedule staff, and reserve key resources, such as operating rooms and imaging machines. Electronic health records and computerized physician order entry bring these elements together online, automating charts, records, and medical information about patients and directing medical staff toward protocols clinically proven to be more effective in treating illnesses. When these technologies are linked to bed management and equipment-scheduling software, doctors, nurses, and administrators can assess current and projected bed counts and optimize the scheduling of key equipment (for instance, x-ray systems) and the level of staffing. This approach reduces not only administrative waste (such as time spent tracking down medical information or calling to secure needed services) but also the level of overbooking, simultaneously improving bed turnover. Reducing the number of adverse drug events

Electronic health records and computerized physician-order-entry systems can sharply reduce the risk of prescription error and negative drug interactions by mapping patient histories with information from drug manufacturers to highlight the risks of prescribing a particular product.

- ***Reducing the number of duplicate tests***

When all health records are stored in electronic format and providers gain access to them through health information exchanges, they become more widely accessible to doctors, insurers, hospital administrators, and patients, regardless of location. This kind of visibility gives clinicians a more complete sense of a patient's history and reduces the need for duplicate tests that can affect the quality, cost, and speed of care. An average hospital can pay back its initial (and usually onetime) investment in two to four years; cost savings accrue year on year. Health care providers with better-integrated systems often realize even higher ROI.

- ***Maximizing the potential***

The realization of the benefits from health care IT investments will require a radically new approach to IT on the part of the CIOs of health care providers, as well as the business leaders and clinicians, the those CIOs serve. Health care providers will need to use new approaches to achieve an inclusive governance process with streamlined decision-making authority, a radically simplified IT architecture, and a megaproject-management capability.

One midsize US acute-care hospital discovered this truth when it implemented an integrated IT system designed to reduce the number of adverse drug events, improve remote access to data, and increase overall patient safety. Rather than taking a phased approach that would have allowed the IT team to factor in lessons learnt as it went along, the team forged ahead simultaneously on multiple fronts. Delays mounted as the hospital's vendor struggled under the volume of the new requirements for software applications. The lack of senior-leadership direction and input from physician leaders meant that the system went live with gaps in the standard guidelines, such as basic guidance on aspirin dosages for patients with heart problems. Rather than reducing the number of adverse drug events, the new system actually raised error rates.

- ***Billing and patient satisfaction***

Financially, the EHR will provide more accurate billing information and will allow the providers of care to submit their claims electronically, thus receiving payment earlier. The patient is happier, as availability of previous information reduces repeated data entry

5.13 Inferences based on region –Asia Pacific and Rest of the World

Compared to problems faced by developed countries in the implementation of Information Technology, developing countries present far more significant challenges and limitations. Notwithstanding, many EMR systems have been successfully implemented. EMR and PHR implementation in developing countries presents many benefits that can improve healthcare management. To enable use of IT based applications, a country requires appropriate IT infrastructure. Increasing availability of wireless telecommunications, mobile and adhoc networks are of considerable help. Growth rate of mobile subscriptions has been more than 82% annually. In Cameroon, Kenya, Senegal and Tanzania, annual cellular growth rates have been running in excess of 300 percent.

EMR systems are currently amongst the prime transformers of IT based technologies in healthcare. Healthcare users and consumers of EMR in Kenya, India, and Haiti have been reaping the benefits. These systems, provide greater accuracy, efficiency and cost benefits.

Benefits or EMR include efficient clinical management, improved diagnosis, reminders, and simple warning tools that help clinicians and patients reduce possible errors like drug incompatibility and interactions resulting in significant improvements in quality of care. Networked EMR systems can enable laboratory data to be entered from remote locations. Specific benefits of PHR and EMR systems include

- Facilitates speed and accessibility in obtaining consultations from distant specialists.
- Makes clinical notes and documentation legible, reducing clinical errors associated with illegible handwriting.
- Provides reminders to routine screenings, prescriptions, administration of vaccines and other health maintenance benefits.
- Generates warnings for abnormal laboratory results.
- Supports the handling of data for clinical research.
- Assists in the management of chronic diseases such as hypertension, diabetes etc
- Provides information on drugs for prescribing.
- Supports program monitoring, including reporting outcomes, budgets and supplies
- Backs-up data
- Provides ease to information transfer and sharing.

EMR systems provide a myriad of benefits to enhance the efficiency of healthcare delivery systems in developing countries.

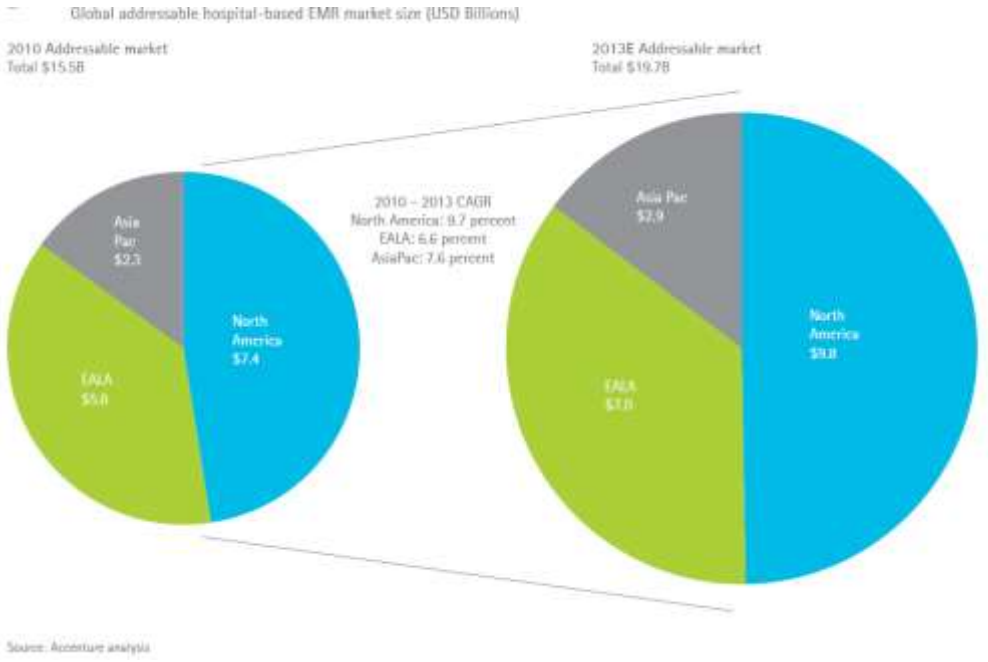


Figure 5.17 Overview of International EMR/EHR Markets: Results from a Survey of Leading HealthCare Companies August 2010

Figure 5.18 Additional Factors Impacting Size and Growth of Global EMR Markets

5.14 Generalization on Digitization Benefits and Risks and Costs

Electronic Health Records and Health care IT implementation is indeed a driver towards an effective, efficient and optimized health delivery model. The purpose of digitization is to achieve better outcomes.. Benefits clearly outweigh risks. but are not always direct and instantaneous. There are issues around adoption and sustenance of digitization initiatives. Issues around adoption include lack of motivation in the organization, poor leadership and management support, extended length of entire implementation process, inadequate skill sets and computer literacy and lack of change management to adopt newer work and process flows.

The organization's overall outlook to business is clearly transformed with an in-depth view of information on all aspects of the business. This enables low level and detailed analysis to be established. This helps organizations monitor, track and continuously improve to achieve effective results.

5.15 Conclusions

Technology is a critical tool in achieving the benefits of health information exchange (HIE). However, technology alone is insufficient. Healthcare industry stakeholders who base their HIE solutions solely on technology, do so at the expense of underlying health information management principles. Disparate HIE principles, models, definitions, products, and standards often camouflages crucial policy and process decisions an HIE initiative must make, in the early stages of its development. Transmitting patient data electronically without attending to the business processes surrounding the data capture, translation, and transmission has the potential to increase patient risks and healthcare costs. Data accessibility, reliability, and accuracy are therefore critical success factors in obtaining the trust of stakeholders, including consumers, and in sustaining long-term data exchange on a large scale.

Electronic health records can improve care by enabling functions that paper medical records cannot deliver

- EHRs can make a patient's health information available when and where it is needed – too often care has to wait because the chart is in one place and needed in another. EHRs enable clinicians secure access to information needed to support high quality and efficient care.
- EHRs can bring a patient's total health information together to support better health care decisions, and more coordinated care.
- EHRs can support better follow-up information for patients – for example, after a clinical visit or hospital stay, instructions and information for the patient can be effortlessly provided and reminders for other follow-up care can be sent easily or even automatically to the patient.

EHRs can improve patient and provider convenience – patients can have their prescriptions ordered and ready even before they leave the provider's office, and insurance claims can be filed immediately from the provider's office.

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6 Expert Systems for the Digital Healthcare World

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6.1 Introduction

Healthcare has for long been plagued by the problems of access, affordability and quality. Even today over 70% of the worlds' population, by some estimates have no access to quality healthcare. Efforts to solve the problems have predominantly involved "more of the same" solutions, creating more doctors and nurses, incentivizing them to serve in rural areas and building more hospitals. These are no doubt required, but the pace of progress in many of these areas, has meant that generations of people the world over, have lost their lives waiting for the impact of these initiatives to reach them.

Quality healthcare remains a distant dream for the vast majority of people in India. Public Health Infrastructure is on the verge of collapse in many states and while Primary care has certainly improved across the country, the state of secondary and tertiary care in the Government sector still remains poor. The private sector has stepped in to fill this gap. Unaffordability and lack of insurance penetration (less than 30% of Indians have health insurance) has resulted in quality affordable healthcare continuing to elude the great majority.

In most other areas of human endeavor, there have been dramatic changes, powered by technology. Healthcare continues to languish almost in a time warp held hostage to a large extent by the very industry that was created to solve the problem. Today the healthcare industry is perceived to be a self obsessed, materialistic behemoth, as intent on ensuring its hegemony, as it is on reaching out to the needy. It would be wrong to imply that the healthcare industry has not adapted to the use of technology. Modern technology is all pervasive in today's healthcare. However the use of that technology has not necessarily ensured greater access or affordability of healthcare though it has had a major impact on quality, to those who can access and afford it.

So can this technology be adapted to make healthcare more accessible and affordable? Yes it can. What then is the problem? The problem is in the healthcare industry's refusal to use technologies that could impact negatively on its revenue potential and the inability of many Governments to force the issue in the face of "expert opinion."

The first step in improving the healthcare system is to accept the problem. The healthcare industry generally sees itself as only the solution and not as part of the problem. So, according to them, the answers to the problems of access, affordability and quality are simply to have more healthcare professionals and more infrastructure in place. There is no doubt that this is important. Merely having more doctors and nurses and improving access is having little impact on affordability and quality. In fact even on access, this has not had the impact it should have had. Despite incentivization doctors are generally not keen to serve in rural areas

and specialists do not wish to relocate outside metros. Increasing numbers alone without improving quality will not suffice.

Out of the box thinking is needed and this is where technology plays a game changing role. Just how accurate is the doctor when he or she makes a diagnosis? The honest answer is that nobody knows. Except in a handful of specific and major medical conditions, the industry is not even measuring the quality of the care provided. It is well known that a number of patients who present at an outpatient clinic will get well no matter what medicines are given as a large number of medical conditions are self limiting requiring only symptomatic treatment. Quacks survive because of this.

Accuracy of a doctors clinical diagnosis is not measured in most cases. However when a new technology is introduced to make a diagnosis, the benchmark is 100% accuracy and not that of the average doctor. Clinical Decision Support Systems are expected to have unerring accuracy in diagnosing many medical conditions, while the same is not insisted upon with healthcare professionals. The solution to healthcare problems will come from a combination of innovation and judicious use of technology with an underlying conviction that RoI (Return on Investment) is not the only factor. What are the technologies that can help improve profit access and affordability?

For long Telemedicine has been touted as one of the major ways of taking quality healthcare to underserved populations. Yet four decades after the first Telemedicine programs were launched, it still remains a novelty that has not been mainstreamed. The reasons are not difficult to understand. Telemedicine has failed to provide a robust business model for the healthcare industry and this fact more than anything else has meant that its adoption has been limited.

Hospitals make more money seeing patients in person and ordering tests than they can by offering a remote consultation. Patient satisfaction levels tend to remain low as patients often believe that seeing a doctor face to face will ensure better diagnosis and care. Today, a number of medical devices can be interfaced as part of smart telemedicine systems. Patients can be monitored remotely by experts and indeed are, in some of the best centers in the world. An ICU bed has video and audio outputs. The patients electronic medical record can be viewed remotely as can the output of medical devices connected to the patient. Radiology images can be viewed cost effectively and scans can also be performed through tele mentoring. Yet adoption of these technologies remains low and paradoxically is higher in setups that already provide high quality care. Africa was hyped as the big continent where tele health technologies could transform healthcare. Yet an honest assessment indicates, that barring a dozen or so projects with limited reach, Telemedicine has failed to significantly impact the quality of care in Africa.

For many years the doctor's touch symbolized the completeness of the patient encounter. It was believed that without the doctor examining the patient in full and laying his hand on the patient an accurate diagnosis was not possible. Technology has changed this premise. Today a cardiologist hardly ever makes a diagnosis based on what he hears using a stethoscope. Even if he does hear something abnormal therapeutic intervention is only after getting an ECG,

echocardiogram or a Holter – all technology dependent. So why can't patients be evaluated by expert systems, that can advise relevant tests. Therapeutic options can then be planned on the basis of these systems and this is then presented to doctors for a final sign off? This may appear to be a radical idea and the medical community could be horrified at such an audacious proposal. However solutions to the worlds healthcare problems may lie in such disruptive innovations.

Tele psychiatry systems help diagnose most psychiatric disorders with an accuracy of over 85%. The health care industry does not accept the 15% inaccuracy discounting that this is acceptable in a human face to face encounter. Most patients with psychiatric conditions are seen by non psychiatrists whose diagnostic accuracy levels are unlikely to be more than 85%. How then can a technology enabled Decision Support System not be accepted when the exact efficiency levels of a clinician have yet to be documented.

6.2 Scenario in a Typical Government District Hospital

It is 9 a.m. and the OPD is overflowing. Queues have been forming since 7 a.m. and there are more than 150 patients cramped into the male and female OPD's. The two doctors available need to see the OPD patients by 11 a.m. and then see their ward patients. Each doctor in a 3-4 hour session may see as many as 70-80 patients. On an average 2-3 minutes are available per patient in which to elicit the history, perform an examination and write the notes and the prescription. The doctors enquire only about the symptoms and prescribe accordingly. They will put the stethoscope on the patient and auscultate because that is socially what a doctor is expected to do. Only in the rare case will the doctor be able to perform a full clinical examination of the complete patient. In many hospitals there are pre prepared drug slips. So for a viral fever patient, upper or lower respiratory tract infection, acute gastro enteritis etc. these drug slips are handed over to the patients based on their symptoms.

How accurate is this 3 minute diagnosis made at most hospitals in India? It is not known. The Government does not measure outcomes or diagnostic accuracy. Even in the private sector systems for outcome measurements are generally not in place. Yet, this system is followed for the vast majority of the country. Indeed this is the case throughout the developing world and not just India. In rural areas the problem is worse. Doctors take turns in showing up at hospitals giving them even lesser time to see patients. Often pharmacists dispense prescriptions .

Perhaps, under the circumstances, the time is ripe to consider introducing Clinical Decision Support Systems. IBM's Watson is one example of a decision support system that can be taken up for mainstreaming(there are others, too) While preliminary studies are going on in the area of Oncology with Watson, the healthcare industry needs to start providing wholehearted support to similar initiatives in other disciplines. Watson uses Natural Language processing to make sense of the medical data including unstructured data (free text entries). There are other types of Decision support systems too and these use rule engines. Rule engines have specific uses and are simply the heart of a different type of expert systems which work very well when dealing with specific conditions. The use of algorithms is widespread in healthcare and rule engines are well equipped to exploit this. In fact it is algorithms that drive

most applications today including social media apps like Facebook, Twitter and of course Google itself.

Rule engines are capable of having complex algorithms configured in them. If patients with possible Diabetes Mellitus need to be screened, based on the ADA criteria of who would be a diabetic, rule engines would deliver a 100% accurate result as the relevant rules are straight forward. While this is a simple example, rule engines are capable of having algorithms, far more complex, built into them. This will enable follow up of patients across visits / time and compare earlier data to provide appropriate diagnostic and treatment options. Natural Language Processing (NLP) based systems are able to work with large volumes of data and "understand" the meaning and patterns in them. The best treatment option for a patient with malignancy and other systemic complications may be provided through an NLP based system .

Both types of Decision support systems are necessary and useful in healthcare delivery and both can be self-learning. As the volume of data available to these systems increases, their ability to provide a more accurate response also goes up. As healthcare goes digital, the data that DSS systems use is not restricted to patient clinical notes alone. It includes images, data from medical devices, patient entered data etc vastly increasing the scope of information processing of such systems. Already *Watson* has developed an ability to interpret select medical images. While this still has some way to go to be put to clinical use the use *of Decision Support Systems* to interpret medical images is not too far away.

With a major shift to storage of data on Cloud based systems also happening, it is envisaged, that vast volumes of data from multiple hospitals can be aggregated and then fed into DSS systems for enhancing their quality even further. In India this obviously will take a little longer as EMR systems are at present used only in a small number of hospitals. The Union Government can help by mandating the use of Electronic Medical Record systems as has been done in the developed world. In India the use of EMR is only recommendatory as of now. EMR standards have been notified but needs to be enforced. Integrating *Decision Support Systems* into the Electronic Medical Record makes sense but what makes even more sense is to put them out for consumers to find. This would be a radical departure from the current healthcare paradigm and hence may not be readily accepted by the Industry. One needs to realize and accept the fact that patients need to be empowered with information. Empowering patients to take better charge of their health is one of the surest ways of improving the quality of healthcare delivery.

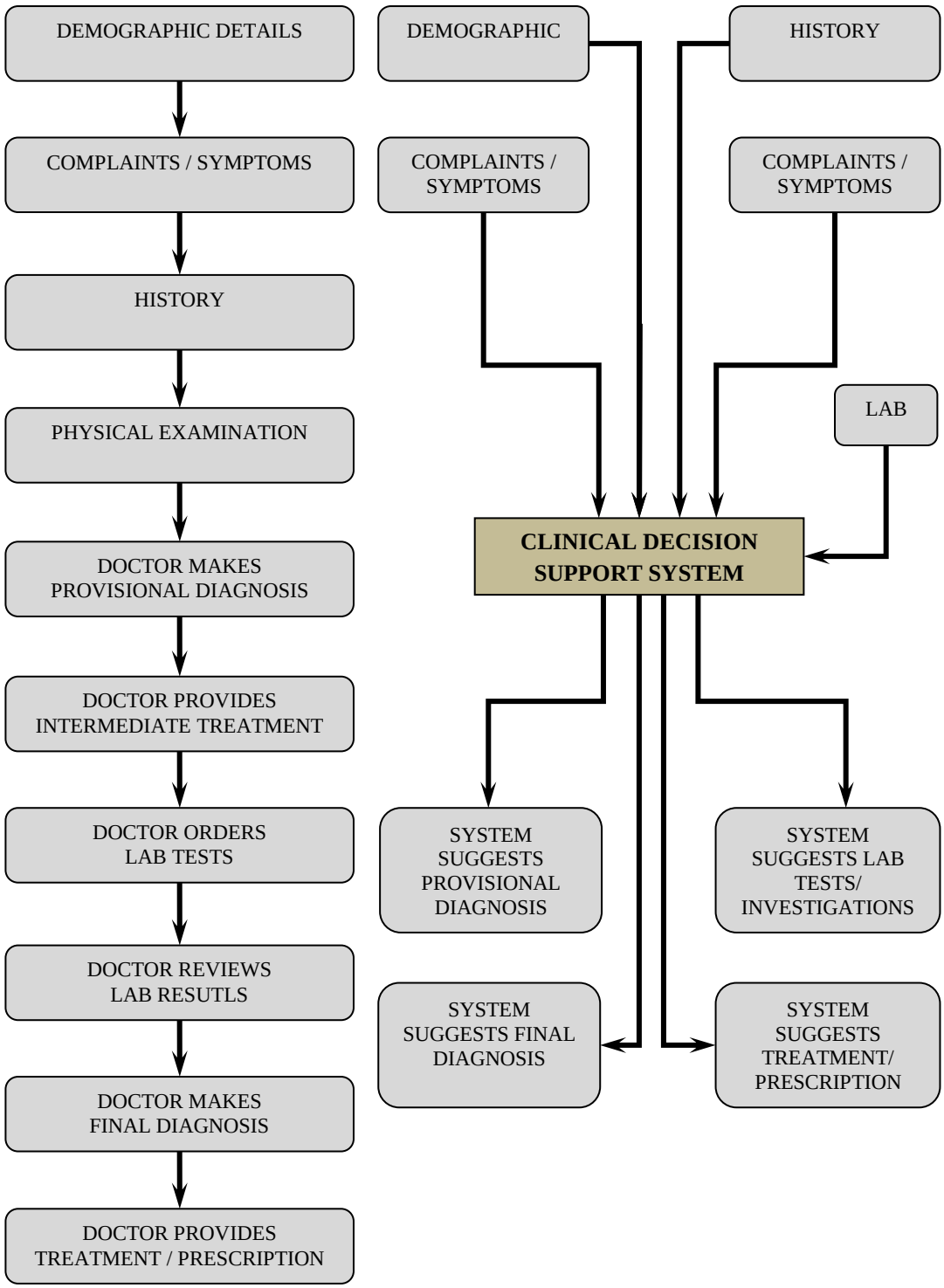
Technology companies around the world with a focus on *Artificial Intelligence* are working hard to build such expert systems and enhance their accuracy levels. It is conceded that such systems will improve healthcare delivery in the future. At present this initiative is primarily originating from technology organizations rather than the healthcare industry or governments. If these principal stakeholders participate potential market size will exponentially increase increasing funding as well. Venture capital firms which are pouring millions of dollars into funding appointment fixing app companies, healthcare directory services and the like are reluctant to look at disruptive models of healthcare delivery, fearing

possible legal and regulatory issues. This needs to change and it will, once a large company comes up with such a system that can target the consumer directly.

6.3 Decision Support Systems of the future

Patients can enter their symptoms and history and the DSS suggests probable or provisional diagnosis and tests required. The patients can get the tests done The DSS would evaluate the tests and give a final diagnosis with a prescription. Where the DSS system detects danger signs or need for follow up it suggests visiting the doctor. Supplemented with trained para medics / physician assistants who can be taught to perform a physical examination and enter this input also into the system the accuracy levels of expert systems can be enhanced even further. Thus only a proportion of patients may actually need to see the doctor. The benefits of this model are enormous. It addresses the current issues plaguing healthcare. It ensures universal access through a web based deployment, if deployed free can make affordability a non issue and because the best protocols are used can ensure quality.

Who wins? Well everyone except the healthcare industry and that is why there is resistance to even carrying out trials of such systems. Patient loads could dramatically go down for doctors and hospitals and with it revenues too !!. Only a global giant like a Google or a Microsoft would have the power to introduce such a disruptive change in healthcare. Smaller companies are more likely to be shouted down by the healthcare industry. The costs of development of such systems for specific conditions are negligible even for medium sized companies. INR 300 million can create expert systems for most common medical conditions. The concern is resistance from the healthcare industry and the fear of regulatory and legal issues. Governments support for developing the product, trials, and user friendly regulations are necessary. With no legacy systems to disinherit emerging economies may actually be able to pole vault compared to the so called advanced countries and take the lead. It needs a visionary and a bold group to take this dramatic leap of faith with expert diagnostic and treatment systems. Someone surely will and hopefully soon. This is the future of healthcare and the lives of billions of people on our planet who can neither access nor afford healthcare depends on it.


DEMOGRAPHIC DETAILS
COMPLAINTS / SYMPTOMS
HISTORY
PHYSICAL EXAMINATION
DOCTOR MAKES PROVISIONAL DIAGNOSIS
DOCTOR PROVIDES INTERMEDIATE TREATMENT
DOCTOR ORDERS LAB TESTS
DOCTOR REVIEWS LAB RESUTLS
DOCTOR MAKES FINAL DIAGNOSIS
DOCTOR PROVIDES TREATMENT / PRESCRIPTION
DEMOGRAPHIC
HISTORY
COMPLAINTS / SYMPTOMS
COMPLAINTS / SYMPTOMS
LAB
CLINICAL DECISION SUPPORT SYSTEM
SYSTEM SUGGESTS PROVISIONAL DIAGNOSIS
SYSTEM SUGGESTS LAB TESTS/ INVESTIGATIONS
SYSTEM SUGGESTS FINAL DIAGNOSIS
SYSTEM SUGGESTS TREATMENT/ PRESCRIPTION

7 Cloud Computing in Indian Healthcare – A Game Changer

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Abstract

7.1 Indian Healthcare - An Overview

Cloud computing has become a very disruptive and innovative technology in delivering computing resources and services. Cloud services encompass several variations of service models for infrastructure, platform and software applications (IaaS, PaaS, and SaaS) and deployment models (Private, public and hybrid cloud). Healthcare industry has been traditionally a slow adopter of technology. However, in India, governmental encouragement and support for digital services, changing customer preferences and the rapid expansion of healthcare providers and payers during the last five years have provided necessary impetus to the healthcare IT industry to leapfrog in technology as it happened in the Indian telecom industry. Healthcare IT vendors around the world are actively redesigning their EMR, PACs, CPOE, ERP, patient billing, claims management and business analytics software to host them on cloud platforms provided by large cloud service providers. In India although cloud adoption is in a nascent stage, its enormous benefits like rapid deployment capability, scalability, OPEX model (with no CAPX-Pay as you use), cost reduction and staffing considerations are driving the care givers and payers to migrate from traditional to cloud-based health services. It is estimated that in the next five years 70% clinical and nonclinical data in India will reside in the cloud and completely change the way care is provided to the patients. Healthcare cloud computing market is expected to reach $9.48 billion by 2020(1) from $3.73 Billion in 2015 at a CAGR of 20.5%accounting for 5% of the entire cloud computing market. Cloud computing may not be a panacea for all the risks and challenges in the workplace but existing and new entrant cloud service providers are fast emerging as trusted, secure, complaint and reliable service providers. A small case study called “Rainbow Digital 2014” which is a cloud implementation project of a 800 bed super-specialty pediatric hospital network in India will also be presented and discussed.

India is the largest vibrant democracy and third largest economy in the world. It is also one of the fastest economies with an annual GDP2 growth rate of 7.6 % of . With a population of just 330 million at the time of independence in 1947, India today has the second largest population in the world next to China, with 1.33 billion (20l6) growing at an annual rate of 1.2%. It is now reaping a huge demographic dividend with almost 700 million of its total population (twice the population of United States) in the most productive age group of 20 to 64 years.. Health indicators have improved eg average life expectancy (from 35 to 68 years) declining maternal and infant mortality rates and eradication of diseases like polio and smallpox. Unlike many western countries, government participation in curative healthcare is only 20%. Rest of the health care is provided by nonprofit for profit and charitable healthcare organizations.

During the last five years there has been a proliferation of large corporate hospital chains with huge private equity, venture capital and foreign and NRI investments. These hospitals have infrastructure and expertise to carry out most complex super specialty procedures like heart and liver transplants, cancer surgeries and radiological interventional and therapeutic procedures with very good outcomes and at far lesser costs than in an American hospital Interestingly, India is also emerging as a favorite destination for medical treatment for patients from Africa, Southeast Asia and Eastern Europe. However, with a low per capita income of only 158US$ per year, poor literacy rate, and poor government spending on healthcare (5 % of GDP), nearly 40% of the children in India are still malnourished, public health systems are not in a good shape and healthcare infrastructure is grossly inadequate. Ironically due to the growing middle class and their sedentary life styles, India is also witnessing a steep rise in non communicable diseases like diabetes, coronary heart disease, obesity etc. This is resulting in a huge disease burden overall.

7.2 Factors Influencing Digital Health Initiatives

Although health insurance is being actively promoted by the government, healthcare providers and insurance companies through various private and governmental insurance schemes, its penetration has been less than 10 percent of the population. According a Deloitte US report, the government's low spending on health care, places much of the financial burden on patients and their families, as evidenced by the country's out-of-pocket (OOP) spending rate, one of the worlds highest. According to the World Health Organization (WHO), just 33 percent of Indian health care expenditures in 2012 came from government sources. Of the remaining private spending, around 86 percent was OOP.

India's health infrastructure is less than that available in other large countries. The U.S. has one bed for every 350 patients while India has one bed for every 1,050 patients. India's ratio of 0.7 doctors and 1.5 nurses per 1,000 people is lower than the WHO average of 2.5 doctors and nurses per 1,000 people. The situation is aggravated by the concentration of medical professionals in urban India, which has only 30 percent of India's population. The industry needs an additional 1.54 million doctors and 2.4 million nurses to match the global average. The shortage of qualified medical professionals is one of the key challenges facing the Indian healthcare industry and therefore HIT advances may help to mitigate some professional and infrastructure deficiencies. India's expenditure on health care information technology (HIT) is very low. Hospitals in India will need to increase their IT spend considerably to provide improved and patient-centric services.

7.3 Healthcare Technology Penetration

"If we had fought the British with cannons instead of swords our destinies would have been different" said, the former Prime Minister of India Mr. P.V. Narasimha Rao. He believed that Information technology is a very potent tool for social transformation and India needed it more than any other country in the world. His historical decisions in the year 1990 like dismantling the license raj, opening up the country for foreign investment and promoting modern technologies, led to India becoming the IT power house of the world. However Indian healthcare industry traditionally has been a slow adopter of information technology when compared to other industries like banking, manufacturing and retail. Until the last decade, healthcare providers' primary focus in using *IT* had been on automation of back-office

systems, reimbursement methods and regulatory compliance and accreditation requirements. IT budgets have been very low as they were not considered as a part of infrastructure and had to compete with other priorities like medical equipment and hospital expansion budgets.

7.4 Understanding Cloud Computing Technology

By definition, cloud computing is a pay per use model for enabling available, convenient, on demand network access to a shared pool of configurable computing resources (e.g. Networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management of effort or service provider interaction. The cloud is transforming the way we are deploying *IT* For the consumer, it is the way to procure hardware and software and for the supplier it is the way hardware and software is sold as a service. People flying in commercial airlines rather than owning their own airplanes would be an apt analogy ,Cloud computing services is like having a large amount of hardware and software resources which is owned by a third party (although physically located remotely) and anyone is able to access that useful resource without owning it.

According to Mr. Steve Jobs, founder of Apple computers 'Innovation is all about making complex things simple. Cloud and mobile based technologies have exactly done that and therefore there is a gold rush to adapt them. These are truly transformational and there is no doubt that early adopters will be on top of the curve. To quote Mr. Sathya Nedella CEO of Microsoft, "Cloud and mobile technologies are truly revolutionary and are going to change the way large enterprises are going to be run their businesses in the future. I would like to a see a Cloud first and Mobile first world"

7.5 Cloud Service Models (IaaS, PaaS, and SaaS)

Cloud computing should be better understood as the use of computing resources both hardware and software that are delivered as a service over a network. Cloud as a service is provided to the users in the following service models:

- *Infrastructure as a Service (IaaS***)** for processing, storage, networks, and other computing infrastructure resources
- *Platform as a Service (PaaS)* to deploy applications developed using specified programming languages or frameworks and tools on to the cloud infrastructure
- *Software as a Service (SaaS)* to access applications running on a Cloud infrastructure from various end-user devices (generally through a web browser).

7.6 Cloud Deployment Models (Private/Public/Hybrid)

Deployment can be done in three different ways:

- *Private clouds* operated solely for one organization only or for an individual person. *Public clouds* that are open to the general public or large industrial groups and are owned and are usually managed by a cloud service provider
- *Hybrid clouds* combining two or more clouds (private or public) that remain unique entities but are bound together by technology that enables data and application portability.

7.7 Key Characteristics

- ***Measured Service:***

IT infrastructure and applications are delivered and consumed as a service over the network

- ***Rapid Elasticity and Homogeneity***

Services operate consistently Regardless of the underlying systems. capacity and performance scale meet demand and are invoiced by use

- ***Multi-tenancy and resource Pooling***

Services are shared across multiple organizations, allowing the same underlying systems and applications to meet the demands of a variety of interests, simultaneously and securely

- ***Location Independence and ubiquitous network access***

Applications, services, and data can be accessed through a wide range of connected devices (e.g., Desk tops, smart phones, laptop other mobile devices) at any time and any place using a high band width connectivity

7.8 Benefits

Elasticity

Elastic (unlimited) Public Cloud scaling can handles traffic bursts. Cloud CPUs scale according to traffic. Conceptualizing, architecting and deploying IT solutions in a health care setting does not need to be a long drawn-out process. Solutions can be built quickly using cloud-based platforms that are already HIPAA compliant. For example, Rainbow hospitals group, Hyderabad moved all their applications in eight hospitals in different geographical locations (800 inpatients 1000 outpatient a day) to the cloud within nine months. It gave all the stakeholders real time access on a dashboard from any place and from any device be it a desktop, laptop, tablet or smart phone .This was the highlight of the recently launched IT transformational project titled "Rainbow Digital"**.** Rapid expansion IT resources was possible for existing healthcare facilities. For new healthcare facilities, IT resources like hardware, software can be rolled out at very short notice (less than a week)

Low cost

Cloud computing empowers providers to only pay for what they need and use. The cloud helps hospitals and healthcare providers to use the applications, hardware, and services on a 'pay per use' model, which allows them to avoid heavy capital expenditure for buying and deploying expensive technology

Ease of Maintenance

To hire and retain IT expertise for in-house infrastructure maintenance in hospitals is a challenge since IT personnel prefer working for core IT companies rather than in IT departments of hospitals. Hence many healthcare institutions have started to outsource the maintenance of in-house IT infrastructure to agencies that have specialized knowledge on

maintenance IT networks and Desktops. In a cloud environment the maintenance of infrastructure facilities like air conditioning, power, air-quality, and operating system for the hardware is shifted to the cloud service provider.

7.9 Risks and Challenges

Though hardware, software and specialized expertise available in established data centers are superior to that available in hospital premises cloud computing may not be the panacea for all the ills in the healthcare IT. As the touch and feel of the servers are not available for the IT personnel and end-users, cloud based systems i appears to undermine the confidence of the hospital IT staff and the top management. . IT managers of Indian hospitals have still not come to terms with the huge impact of the emerging cloud technologies. They need to unlearn and relearn and hone their software skills in new directions. . The Internet of Things, robotic technologies, artificial intelligence, machine learning and virtual desk tops will be widely used in the next five years and these will be operated from the cloud . HCIT personnel need to see the writing on the wall and accept the . rapidly growing mobile and cloud technologies.

Although cloud offers immense benefits like reduced costs, elasticity, efficiency and scalability there are inherent risks like Data center vendor's compliance of service level agreements (SLA), data security at data centers and also the reliability of the networks service providers. Often the escalation matrix in times of crisis seemed to be more on paper than in action and practice and during night times and holidays the service delays can be very frustrating.

7.10 Security, Integrity, Privacy and Compliance

In India, unlike the United States there is no Health Insurance Portability and Accountability Act (HIPPA) , but there are indications that the government is exploring the possibility of putting up a regulatory framework in place. Most healthcare organizations pushback on cloud computing, just because their data is on an outside infrastructure as this leads to concerns regarding security. On the contrary, storing in the cloud can be as secure and convenient as data on their own premises provided enough planning has been done, attention paid to configuration and management of cloud resources . In large hospital chains with number of units located geographically in distant places, managing data on premises is becoming very difficult due to data availability, data integrity and cost of IT expertise, hardware and software resources. It would be easier to protect the data in a central data center with a highly professional and specialized team, rather than protecting the client servers in multiple and distant places.

7.11 Latency Issues

Network is often a neglected part of the cloud computing equation. Most cloud companies like to talk about their latest virtual machines or new software service offerings. Yet the speed (latency) and capacity (throughput) of the cloud provider's network will usually be a determining factor for the viability of any cloud-based software application. Cloud service latency is the delay between a client request and a cloud service provider's response. No matter where the servers are hosted , there is some degree of latency between the servers and the users, as information is passed via switches, between networks and along global fiber optic routes at the speed of light. Latency greatly affects how usable and enjoyable the devices and

communications are. Many factors affect latency, such as the standard number of router hops or ground-to-satellite communication hops on the way to the target server. Because cloud service data centers can be physically located anywhere in the world, a customer may want to find out the geographic location. For example, for an Indian hospital customer, until recently Microsoft Azure and Amazon web services data centers were located outside India unlike CtrlS/Reliance/Netmagic/Airtel data centers which were located in India.The larger and less predictable workload also leads to greater variability in service delivery. Visualization can introduce packet delays, especially if virtual machines (VMs) are on separate networks. The customer network's wide area network (WAN), if busy, can also have a significant effect on latency. Some organizations invest in a dedicated WAN for cloud operations.

The bottom line from all of this is that, for average software applications which need to operate on trans-continental scales, or high performance software systems which need to operate on very fast response times, the network latency consumes the major part of the target response time one has to meet. For example, for web-based services between the USA and Europe, a response time of 200 milliseconds, network latency of 150 milliseconds is required. Therefore, every millisecond improvement in network latency means more time to process the response within the data center.

7.12 Global Healthcare Cloud Computing Market

- *Healthcare cloud computing market analysis and global forecasts to 2020* report by Markets and markets.com provides great insight into the global healthcare cloud computing market. It has segmented the market on the basis of application, service model, deployment model, pricing model, component, end user and region.
- *Application* - the healthcare cloud computing market is categorized into clinical information systems -(CIS) (PACS, EMR, CPOE, RCM, Claims Management) and nonclinical information system (NCIS). In 2015, CIS accounted for the major share of the healthcare cloud computing market.
- *Service model* - this market is segmented into Software-as-a-Service (SaaS), Information-as-a-Service (IaaS), and Platform-as-a-Service (PaaS). In 2015, the Software-as-a-Service (SaaS) segment is accounted for the major share of the market.
- *Deployment Model* - Private cloud, public cloud, hybrid cloud and Community cloud. In 2015, the private cloud segment accounted for the major share of the healthcare cloud computing market.
- *Pricing Model* - Pay-as-you-go and spot pricing. In 2015, the pay-as-you-go segment accounted for the major share of the healthcare cloud computing market.
- *Component* - Hardware, software, and services. In 2015, the software segment accounted for the major share of the healthcare cloud computing market.
- *End users* - Healthcare providers and healthcare payers. In 2015, the healthcare providers segment is estimated to account for the major share of the healthcare cloud computing market.
- *Regions* - Divided into North America, Europe, Asia, and the Rest of the World (ROW). In 2015, North America accounted for the largest share of the healthcare cloud computing market, followed by Europe and Asia. North America is expected to continue to grow at the highest CAGR during the forecast period.

Over the years, the adoption of cloud computing in healthcare is likely to increase owing to the rising need to curtail healthcare costs, enhance the quality of healthcare, and bring in reforms benefiting healthcare IT, proliferation of new payment models, cost-efficiency of cloud technology, and the implementation of the Patient Protection and Affordable Care Act (PPACA) in US. However, the security of patient data on cloud is a crucial issue that is likely to restrain the growth of this market.

Some major players in the global healthcare cloud computing market include Athena health, Inc. (U.S.), CareCloud Corporation (U.S.), ClearData Networks, Inc. (U.S.), Carestream Health (U.S.), Dell Inc. (U.S.), GNAX Health (U.S.), IBM Corporation (U.S.), Iron Mountain, Inc. (U.S.), Merge Healthcare, Inc. (U.S.) and VMware, Inc. (U.S.).

7.13 The India Story

In India large healthcare providers have realized the benefits of cloud based applications. It is being rapidly deployed in new ventures replacing legacy systems and implementing state-of-the-art cloud technologies across all their hospitals Notable among the converts are Fortis Health Care, Apollo hospitals, Lal Path Labs, Narayana Hrudayalaya , Rainbow hospitals group and LV Prasad eye hospitals .Rainbow hospitals group has the distinction of being the first hospital in their region to host all their applications including hospital information systems, electronic medical records and their back-office functions like finance, materials, human resources and e mail services for eight of their hospitals in India .Dr Ramesh Kancherla ,Chairman and MD of Rainbow hospital group in Hyderabad says “Deploying resources on the cloud has not only helped us to standardize the systems ,processes ,IT infrastructure but also to reduce turnaround times for tests ,provide clinician access from anywhere any time, very closely monitor operational costs and above all improve patient experience" .

7.14 Data Center Service Providers

Cloud technology is set to take the Indian healthcare IT system by storm in the next five years. Penetration of cloud has been at a minuscule level in Indian hospitals and a multibillion dollar business is on the anvil. .However considerable planning, education, cost analysis and good implementation processes needs to be executed before jumping in to the cloud bandwagon to reap the real benefits .Data centers are generally located far away from the hospital premises and even outside the countries where the health care facilities are located .Reliability , credibility and commitment of service of vendor is of paramount importance. 99.99% up time and data security guarantee have to be carefully negotiated before signing up for service. A personal visit to the prospective vendor site is strongly recommended.

Table 7.1 List of Major Cloud Service Providers in India

Reliance data center	Airtel data center
Netmagic cloud Infrastructure Services	CtrlS datacenters Limited
Microsoft Azure Ricoh India Limited	Tata Consulting Services
Amazon Web Services	Nextgen

There has been an exponential expansion of cloud infrastructure in India during the last two years. This is mainly because existing cloud service providers and global IT companies like Microsoft, Amazon and Google who are the new entrants in the market are building huge capacities to meet future demand both in the private and the government sector. Microsoft and Google are dropping their prices for virtual machines by 30 to 40% to enter very potential markets like India. Healthcare organizations who are venturing into cloud hosting must enter into contracts in such a way that they are able to avail benefits of falling prices in future

7.15 Network Vendors

It is important to make the correct choice of the telecom network provider who will guarantee 99.9% uptime for the high-speed MPLS connectivity. It is essential to have redundancies built into the network connectivity like the primary, and secondary network from the connectivity network provider. An alternate established vendor should be available in case the primary and secondary MPLS connectivity of the primary vendor fails. Underground fiber-optic cable connectivity is recommended in place of RF connectivity, which is prone for disruptions. Fiber-optic underground connections are protected from the vagaries of weather and physical dislocation due to infrastructural development work that may be undertaken by the government. Due to the intense competition in the telecom industry and government's plan for the rapid deployment of fiber-optic connectivity to even remote villages, the quality of broad band connectivity is set to improve in India over the next five years. Bandwidth charges will decrease and speed of connectivity will move from Mbs to Giga bites per second as in the United States. When allotting budgets one needs to be future ready.

Airtel, Vodafone, Tata, Reliance and BSNL are the active service providers in India. It is advisable to enter into to a long term service agreement with these vendors with Service level Agreements (SLA) and with clauses to review prices annually. Due to rapid expansion of Data connectivity infrastructure in India, during the last two years, connectivity charges are going down as in other countries . a Hospitals need to enter into supply contracts taking this into account.

7.16 Hospital Information Systems (HIS) Vendors

Due to late adoption of *Information Technology* in healthcare, many HIS vendors have not been able to work on cloud based systems and do not have software which can be deployed on the cloud. Further many of the large hospitals have not moved from the traditional methods of using finance, materials and HR software modules from the traditional HIS vendors. It is only in the last five years as in other industries healthcare has also started using ERP packages. Rainbow hospitals group is one of the few hospitals in India where SAP for Finance and materials management and Adrenaline? Software from Polaris for their human resource management, along with HIS and electronic medical records have been hosted in the cloud and integrated with each other. It is time that all HIS vendors develop software for the cloud, to cater to the emerging needs of the Indian healthcare industry.

7.17 Disaster Recovery System

It is ironical that both clients and vendors do not pay enough attention for establishing hot disaster recovery systems while signing deals for cloud enablement. It is essential to plan the disaster recovery system, at least a hundred kilometers away from the data center with real-

time mirroring facility. Though expensive it is absolutely essential. In the recent past, we have seen natural disasters like earthquakes, tsunamis and terrorist attacks occurring suddenly in many parts of the world.

7.18 Rainbow Hospital Group, Hyderabad - Cloud Implementation Case Study

Rainbow Children's hospital is one of India's largest, progressive super-specialty pediatric hospital networks. It has undergone an ambitious transformation using Telstra Health's Arcus Hospital Information System and cloud technology. It is an 800-bed, private, equity-funded group which has positioned itself nationally as a center of excellence. About 600 inpatients and 1200 outpatients are treated across the country each day. Established in 1999 as a single hospital, Rainbow grew to become a chain of seven hospitals over the following decade. The group is now in the midst of a rapid expansion and as per their plan within the next two years will have a network of 11 hospitals with 1,200beds. Its pediatricians and clinical staff will see about 1800 young outpatients and their families every day.

Running an organization of this size and complexity demanded high-level management and business planning. In 2014, it was clear that Rainbow's accelerated growth strategy required a complete digital transformation. This was essential to meet its commitments for ongoing improvements to patient safety, quality of care and efficiencies, as more hospitals came online. Old LD legacy systems were replaced with a new state-of-the-art integrated solution. It was in this background that "Rainbow Digital" project was launched.

Before cloud implementation, Rainbow had two large computer servers - one supporting four hospitals in Hyderabad (Hyderabad cluster) and another functioning as a stand-alone server at Vijayawada hospital. Under Rainbow Digital project their newly procured Arcus Hospital Information System including electronic medical records ,ERP systems (SAP for materials and finance management and Adrelin (Polaris) systems for human resource management) were moved to the cloud using a well-established Tier4 cloud service provider, namely CltrS limited, Hyderabad. CltrS has data centers in Hyderabad, Mumbai and Delhi.

Cloud-hosting has enabled Rainbow to scale, up or down, its infrastructure requirements based on fluctuating and evolving demand with minimal investment. Moving to the cloud gave the hospital access to IT experts with high-level specialist skills who can make changes and update software very quickly. This gave in-house IT personnel time to focus on innovating and improving their existing software applications with newer technologies and also provide better support and training to the hospital IT users at the hospital. Cloud hosting also provided the facility to access data and share information about a patient anytime, anywhere using any one of a range of mobile devices.

Table 7.2 Major Advantages of Cloud Enabled Arcus HIS System in the Rainbow Hospital Group

Sl. No	Advantages
1	Rainbow hospital clinicians who are visiting multiple hospitals in the group in at different times are now able to access HIS and order for tests ,procedures, view reports and write notes from remote locations (from any hospital unit or from their homes) using desktops, laptops, tablets and mobile phones, simultaneously getting notifications, emails and text messages
2	Group purchasing and centralized store management for all hospital units with SAP hosted on the cloud was enabled. This helped reduce inventory and material purchase costs
3	Real-time dash board reports on number of patient visits ,inpatient and outpatient billing, pending laboratory reports, manpower and material cost s greatly improved operational efficiencies
4	Turnaround times in laboratory, radiology department ,operation theatres and OPD areas came down by almost 40 to 50 percent
5	Configuring third party software, laboratory equipment and tariff across all the version upgrades of application software ,operating systems and tools became simpler They could now be done centrally on the cloud, eliminating the need to be done in each hospital server.
6	Responsibility of ensuring security, integrity, and privacy of patient data shifted to the cloud service provider from the hospital IT department.
7	Legacy software in existing hospitals was replaced by new Telstra Arcus HIS one after another over a period of one year with a time gap of one month. After cloud implementation in all the existing hospitals, existing individual servers, 4 to 5 years old became redundant. Infrastructure maintenance was no longer required in any of the hospital units

7.19 Measurable Outcomes after Cloud Implementation

Sl No	Description	Percentage
1	Improvement in documentation accuracy	60
2	Increase in patient satisfaction rates	50
3	Reduction in theatre waiting time	60
4	Reduction in laboratory test results turn around times	50
5	Improvement in radiology turn around times	50

7.20 Conclusions

India with its highly qualified and trained medical expertise, state-of-the-art medical facilities and with its huge cost advantage is fast emerging as the medical tourism hub for the world. Domestic medical industry is also growing at about 15 %, much ahead of the GDP of the country. The exponential growth of ICT technologies will open up great opportunities as well as challenges for Indian healthcare industry. It is estimated that the cloud based technologies alone will offer about $ 241 billion business by the year 2020 and India can surely benefit by it being the power house for the world in the IT sector. Our care providers, technologists and hospital promoters must learn to align their goals with emerging disruptive technologies and become the power house for the world in the IT sector.

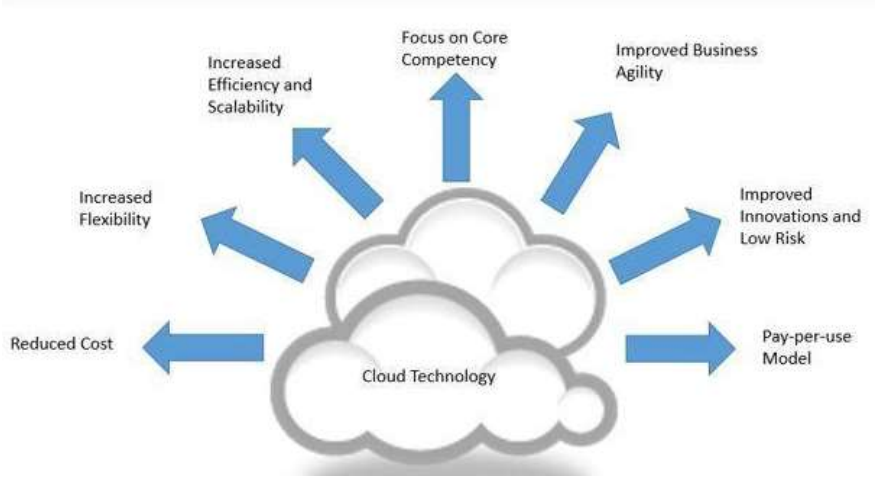

Figure 7.1 : Cloud Computing Benefits

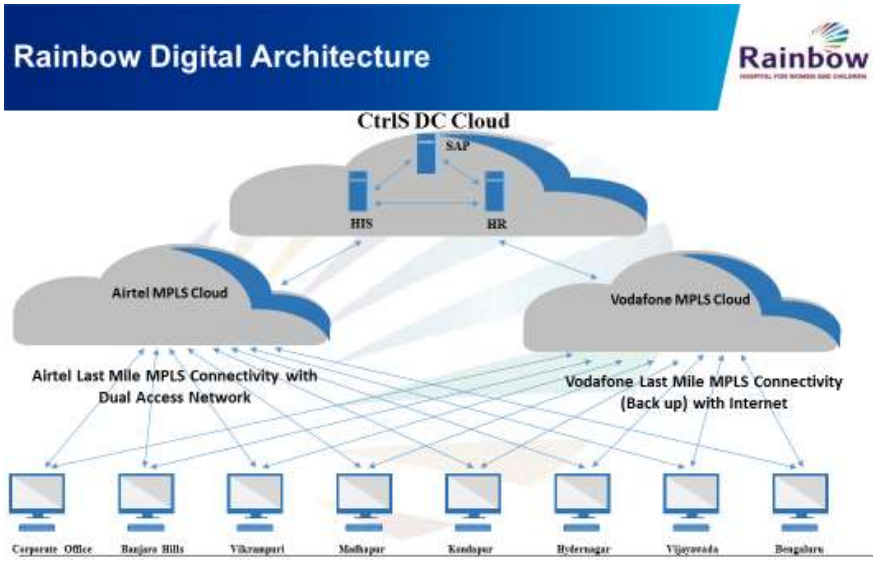

Figure 7.2 Rainbow Digital Architecture

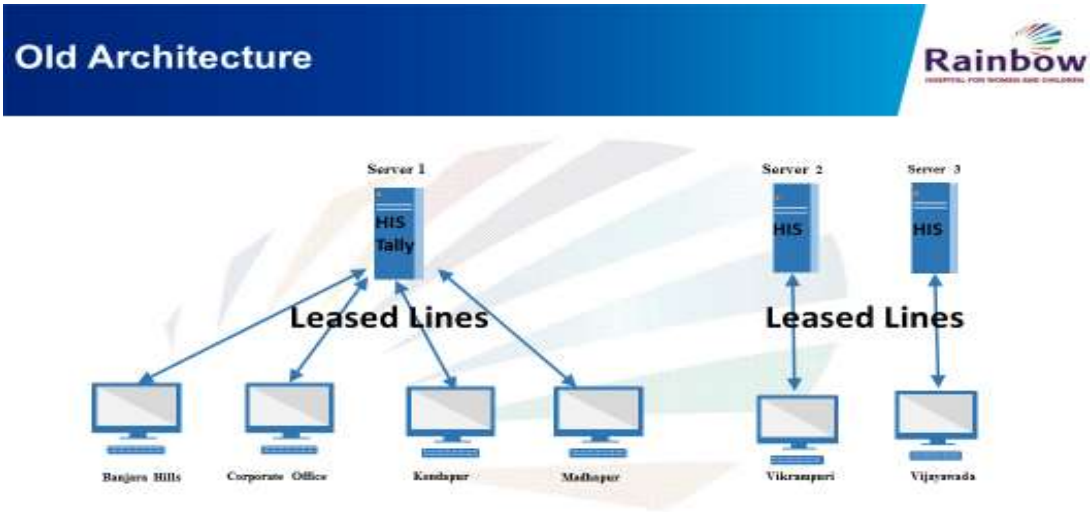

Figure 7.3 Old Architecture

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8 Privacy and Security Issues in eHealth

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"Security is not an end product but a continuous process"
"Privacy is not something that I'm merely entitled to, it's an absolute prerequisite"

8.1 Introduction

This article reviews the current Indian and global scenario of privacy and security issues, in eHealth, now and in the future, from a health provider's perspective. eHealth, itself has not come of age particularly in the developing countries. The complexities of privacy and security in a continuously evolving eHealth system are many. eHealth in India will not be standalone but part of a multi-purpose e-governance system catering to millions of just -becoming - computer -literate end users of IT. Measures to implement privacy and security, in this context with its limitations, will be discussed. Solutions will have to be cost effective, customized and applicable to a heterogeneous population. Immediate imposition of stringent global e-security measures in suburban and rural India could even be viewed as a forward step in a backward direction. This article would essentially serve to create awareness and sensitize all stakeholders, to what, could soon be a burning issue.

As per the World Health Organization, e-health means "the use of Information and Communication Technologies (ICT) for health". The definition, though concise, is not very helpful. The European Commission has put forth a more elaborate definition of e-health. E-health "refers to tools and services using Information and Communication Technologies that can improve prevention, diagnosis, treatment, monitoring and management".

With WHO planning to integrate eHealth in all health systems globally "eHealth for all by 2025" may well be part of the Millennium Development Goals. The 2006 WHO report on "Building Foundations for eHealth" confirms that worldwide, the eHealth movement has commenced. With the netizen of tomorrow living in a global village and the hospital of the future having no walls, distance will become meaningless and Geography will become History ! This will result in eHealth becoming a reality. Speaking different languages, with different educational and socio economic status, with varied access and knowledge of modern ICT, creating a uniform national infrastructure for e-security and e-privacy in India for 900 million living in suburban and rural India, and 400 million living in urban areas, is more than a challenge. Following the west, is not the solution. Customised, need based, culture sensitive solutions are necessary. Luckily we have no legacy systems to disinherit. We do not have to rewrite the past, follow, piggy back or even leap frog . Today, we can pole vault and develop our own rules and regulations keeping in mind the necessity to fit into global standards. India will no longer be striving to achieve world class. The rest of the world will be striving to achieve India class ! Our culture is different from the west. Primarily instigating litigations is

not in our DNA. The term “trust” is still in our lexicon and therefore we are not paranoid about security. However, the current legal and regulatory landscape that governs e-health is scattered and ambiguous. There is no or very little legal scholarship in the area of e-health in India.

It is universally acknowledged that the health care industry will exist, so long as humankind exists. Though slow to start using ICT, when compared to other industries, the inter-industry-digital-divide will eventually be bridged. Unlike other industries, when the use of ICT in health care becomes complete, every single citizen would be directly involved. It is therefore essential that not only do we create awareness among the stakeholders about privacy and security issues we should identify them and start instituting preventive measures from day Zero. This however should be done with considerable tact, being sensitive to different view points. We should understand that the average Indian is primarily unlikely to resort to complex manoeuvres to get details of another’s health status. At the same time information about public health needs to be guarded with the highest security levels, as it involves national defense. Technological challenges are many. Some have been overcome, others have been bypassed, many remain to be addressed. Various issues ranging from the use of different types of connectivity, standardization of hardware, software, middleware, brainware, legal frameworks and security technology face us.

When e Health in India becomes a reality, issues like national and international licensure, credentialing, standards, quality control mechanisms and authentication will have to be looked into. A solution is not a solution unless it is cost effective, universally accepted and applicable. Social, ethical and legal solutions can never ever keep up with constantly evolving technology. The request for security should also come from the users, rather than be imposed from above. A pre mature hype on privacy and security may actually thwart growth and development of eHealth. Expertise on privacy and security aspects of eHealth systems being deployed in resource constrained environments is lacking

Security issues in modern health care, now and in the future, from a clinician’s perspective, may differ from that perceived by an IT security expert. The 18th Annual HIMSS Leadership Survey, of health care CEO’s indicated that security is a concern. Healthcare IT professionals identified an internal breach of security as their primary concern regarding security of data in their organization. 18 percent of respondents indicated that their organization had experienced a security breach in the earlier six months. Respondents were planning to adopt multiple measures to facilitate data recovery in their organization. The complexities in an eHealth system, the large number of players and the dynamic changes, result in these issues being quite different from those in e Commerce.

Interestingly, the 'right to privacy' is not spelt out in the U.S. Constitution and most other constitutions However, the U.S. Supreme Court has repeatedly upheld, that privacy is an implied right, in several amendments in the Bill of Rights. Many of the court cases in which the right to privacy has been upheld, have been related to personal / private health decisions. In most countries, confidentiality is a legal obligation, but the demanded level is variable.

8.2 The Indian Scenario

Notwithstanding the increasing concern being exhibited by IT security specialists, the author a clinician, is unaware of any reported breaches in security or privacy of a patient's eHealth record in India. Even in the USA where malpractice suits, in face to face clinical practice, is high, court cases primarily on eHealth issues are still rare. As a reasonable guestimate at least a million teleconsultations would have taken place in India so far, the majority being in ophthalmology. At the largely attended National Telemedicine Users Meeting held at Ahmedabad in May 2007 organized by the Indian Space Research Organisation no one was aware of any complaint of breach of security or privacy. In subsequent eHealth conferences, over the next decade, this topic is regularly addressed and again there is no mention of a " test case" of security breach in telehealth in India. This is not because ideal high level security measures are in place, but simply because unlike in e commerce, the immediate 'benefits" of "hacking" are not comparable. The chances of there being deliberate malicious attempts in India to obtain access to health records of others at this point of time, sounds less likely.. This is not to ignore necessity for introducing security measures in eHealth. The author is of the opinion that this should be dealt with in the right perspective.

During the last 17 years several groups of people spearheaded by Apollo Hospitals Group, Indian Space Research Organization, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, Sankara Nethralaya, Chennai , Aravind Eye Hospital, Maduai, Sri Ramachandra Medical University, Chennai, Narayana Hyrudalaya, Bangalore and others have gone into the nuts and bolts of designing customized, cost effective, need based telemedicine models using appropriate technology. Many technological issues have been identified and corrective measures instituted. A major concern of the health care provider, wanting to use telemedicine, are the medico legal implications of offering consultation and treatment from a distance. Though guidelines have been suggested there is no regulation at present.

A white paper "Recommendations on Guidelines, Standards and Practices for Telemedicine in India" was formulated by the National Task Force on Telemedicine , constituted under the aegis of the Union Ministry of Health and Family Welfare, as early as 2006. The 88 page report touched upon privacy and security issues. Obviously this is not even the tip of the iceberg. Most health care providers, health administrators and the thousands employed in the health care area, need to be informed about privacy and security issues in electronic transfer of health data. The eventual end user of e Health, the millions of ' IT unsophisticated' rustics blindly trusting their doctor, may not be aware that their personal health information in cyberspace can be hacked and misused.

8.3 Laws Relevant to IT Security in eHealth in India

The Information Technology Act, 2000 ("IT Act"), The Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011 ("Data Protection Rules") and the Information Technology (Intermediaries Guidelines) Rules, 2011 ("Intermediary Guidelines") are the specific Laws relevant to IT Security in eHealth in India.

e-Health involves a constant exchange of information between the patient and the service provider. The patient's personal information, such as medical history and physiological

conditions, are considered Sensitive Personal Data or Information ("SPDI") under the Data Protection Rules. When a body corporate collects, stores, transfers or processes such information, certain requirements under the Data Protection Rules are triggered.

Consent is one of the major requirements under the Data Protection Rules. Before a doctor or an institution does anything with a patient's data, they are required by law to obtain consent in writing. The patient must be informed about the fact that the data is being collected, what it will be used for and whether it would be transferred to any third parties, along with the contact details of the agency collecting the information. There is also a requirement for body corporates to have a privacy policy in place and published on its website. This consent is usually obtained by having the patient accept the terms of the body corporate's privacy policy. w This information, in addition to the security practices the body corporate has adopted to keep the information safe is to be displayed. . If the SPDI is planned to be disclosed to a third party, prior permission of the owner of the SPDI is to be obtained. In cases where the SPDI is being transferred, the body corporate transferring the SPDI must ensure that the receiver of the SPDI has adequate security practices in place.

The Drugs & Cosmetic Rules require a prescription to be in writing and signed by a registered medical practitioner. Under the IT Act, a document that is required by law to be in writing, would be deemed to be in compliance of such law if the same is made available in an electronic form and accessible in a way that it can be used for future references. Hence a prescription uploaded online would fulfill the first requirement of a valid prescription, under the D&C Rules. However, the IT Act further states that where a law requires for a document to be signed, it would be deemed to be in compliance only if such information or matter is authenticated *by means of an electronic signature.* Affixing an electronic signature to any document thus becomes essential for it to fulfil a legal obligation mandating a regular signature. *This would imply that uploading a scanned copy of a prescription may not be recognized as valid under law*. Knowledge of these regulations are relevant when designing security measures.

Some e-Health services have set ups that merely facilitate the interaction between the patient and the service provider and are not directly involved in the provision of the services. In such cases, the service provided would be considered an intermediary under the Intermediary Guidelines and the IT Act. There are certain relaxations that are given to intermediaries in terms of liability of third party data or communication, provided they observe certain due diligence requirements under the Intermediary Guidelines. These requirements are extensive, and include having, a terms of use, in place, removal of offending/unlawful material within 36 hours of a request and appointing a grievance officer. The relaxation would apply only if the intermediary does not initiate the transmission of the data/communication, select the receiver of the transmission or select or modify the information in the transmission.

8.4 Definition of Privacy, Confidentiality and Security

Information Privacy is the ability of an individual to control the use and dissemination of information, that relates to himself or herself. Privacy is an individual's claim to control the use and disclosure of personal information.

- ***Confidentiality*** *is a tool for protecting privacy. Sensitive information is accorded a confidential status that mandates specific controls, including strict limitations on access and disclosure. These controls must be adhered to, by those handling the information.* Confidentiality is a status, accorded to information, that indicates it is sensitive for stated reasons and therefore must be protected, and access to it controlled.
- ***Security*** *is all the safeguards* (administrative, technical, or physical) *utilized in a computer-based information system, protecting both the system and the information contained within it, from unauthorized access and misuse, and accidental damage* Security also includes training and policies, not just technologies (i.e. fire walls and encryption). Security protects unauthorized disclosure (also protecting its integrity and availability), and limits access to authorized users in accordance with an established policy.

Health status of an individual is something very personal. Co workers and neighbours, in fact even family members should not have direct access to this information. Third party companies with commercial interests , research entities (academic or otherwise) and hackers should not have access . **Security is more important for banking, while privacy is more important for health**. Security in eHealth care is different from that in ebanking. Unlike e Banking and e Commerce, the status of a health record of an individual does not change significantly. The observations of a senior engineer working in Google HQ is interesting - “I don’t really care, too much if people know about my health status. Worst case I get annoying emails and social interactions. There is not much others can do knowing my health status. They can sell that info and it falls back into annoying category. I might even be happy with others knowing about my health status, as long as it has been sanitised, i.e. they know "somebody in city xxx with education yyy working at zzz industry has health condition abc X" and not "person X who lives at address def has health condition X". The former kind of information can benefit society . Eg. search for "NHS google data". Trends in search behaviour can even help predict epidemics. In finance , consequences are worse. They can steal my money”.

8.5 Necessity for maintaining Privacy and Security of Health Information

The health care provider must keep secure and secret, information concerning an individual, in order to guarantee one’s right to privacy. This is necessary because

a. an individual has a right to privacy
b. Insurance companies obtaining medical information on policyholders could misuse it to deny coverage or claims
c. Potential employers obtaining health information on current or potential employees could misuse it to dismiss or not employ a person
d. Politicians obtaining health information on opponents could misuse it for their own ends

8.6 Privacy of Health Information

a. For most health professionals, maintaining confidentiality is an ethical function.

b. Data Protection Act, European Data Protection Directive 95/46 and Health Insurance Portability and Accountability Act (HIPAA) are some of the laws in force in different countries.
c. During transfer or storage, it should not be possible for data to be modified voluntarily or accidentally. While attempts to modify conventional data often leaves a trail eg erasing words in a letter, scratch on a plain film and so on, detection of electronic manipulation is more difficult.
d. Individual patient data is part of and make up a large data pool. In public interest, the large data pool must be available to epidemiologists and health care planners to ensure better health care for all. The analysis of this data is for common benefit; individual privacy however must be preserved. Data anonymization is therefore essential. A unique identifier is necessary but no standard exists on how to anonymize data. For educational or informational purpose, more and more data is available online. It is often forgotten that something available online should not be systematically, freely used by anyone.

8.7 The Health Insurance Portability and Accountability Act of 1996 (HIPAA)

This is the most significant body of healthcare legislation to be enacted (by the American Congress) since Medicare. It was signed into effect to protect health insurance coverage for workers and their families when they change or lose their jobs (Portability) and to protect health data integrity, confidentiality, and availability (Accountability). HIPAA consists of Titles I-V and places various legal requirements and financial penalties on the healthcare industry. HIPAA is an enterprise-wide issue, not simply an information technology issue. Legal, regulatory, process, security, and technology aspects of each component of the legislation needs to be carefully evaluated. The requirements outlined by the law are far-reaching as all healthcare providers, from large integrated delivery networks to individual physician offices must comply. The Act requires implementation of various mechanisms for ensuring privacy of healthcare information. HIPAA regulations relevant to protecting patient information include Privacy and Security Standards. At present there is no equivalent law in India

8.8 Joint Commission on Accreditation of Healthcare Organizations (JCAHO)

JCAHO has *Information Privacy Regulations* which require that patient information be protected. Extensive federal and state regulations, and guidance issued by numerous healthcare professional organizations in the USA also have similar requirements. The Indian Healthcare Industry is yet to develop such requirements. However there are about 20 hospitals in India which are JCI accredited and therefore need to comply with these regulations.

8.9 General measures to be adopted for ensuring Privacy and Security

Social, cultural, technological, legal, economic issues, standards, and the role of regulatory agencies will have to be considered before enforcing security measures. Secure access to medical information, considered to be very sensitive data, has always been a significant obstacle to develop a centralized archive of patients' data. Concurrently, the availability and massive adoption of a standard for the exchange of diagnostic images (DICOM), the

significant decrease of data storage costs and exponential increase of data transfer speeds have given a stimulus to the development of e Health. Privacy regulations grant healthcare consumers, a greater level of control over the use and disclosure of personally identifiable health information. In general, healthcare organizations are prohibited from using or disclosing health information except as authorized by the patient or specifically permitted by regulations. The privacy rule applies to all personally identifiable health information, irrespective of form - there is no exclusion for written medical records or oral communications. Regulations are applicable to all health information held or created by the covered entity. New technologies have improved ability to electronically record, store, transfer and share health data. While these advances have potential for improving health care delivery, they also create questions about who has access to this information and how it is protected. This technology is threatened by potential unauthorized intrusion. Computer hackers can tap illegally into computer networks, gaining access to and even altering patient records.

Protection of personally identifiable information must be ensured, before consumers, patients and other users are willing to participate in telehealth .The challenge for telemedicine policy makers, is to identify emerging concerns, unique to telemedicine. Lack of privacy and security standards play an important role in the legal challenges facing telemedicine (e.g. malpractice) and have profound implications for the acceptance of telemedicine services. This is particularly so when treating mental illness, substance abuse, and other conditions carrying a social stigma. Organizations should utilize both procedure and technology to limit access to patient information. Clearly stated operational procedures will ensure that the staff associated with telemedicine/telehealth interactions comply with privacy requirements when executing their responsibilities. Physical security measures, will protect the technologies used, in delivering care and sharing information, from harm and misuse. Implementation of technology to limit system access, will provide services, such as authenticating users, ensuring that users can access only information that is needed to perform assigned responsibilities, and logging users off the systems, after a predefined period of inactivity.

Protecting privacy of patient information that is collected via web site interaction using appropriate technology, is an important concern in eHealth security. The procedure should outline requirements for handling electronic messages and attached files and, if the organization has extended its voice mail and facsimile technologies to interoperate with their e-mail systems, also address managing their e-mail-like voice and facsimile messages. Organizations should protect their cross-site transfer of health information using mechanisms that offer a level of protection appropriate to the clinical content of the interaction and the communication method selected to carry out the exchange. For example, based on the perceived sensitivity of the information, an organization using or sending data over public systems or networks might consider using either encryption, application systems that have been designed to protect processed information, or Virtual Private Networks. When exchanging sensitive data with web sites, an organization or individual might elect to use the Secure Socket Layer protocol. Monitoring effectiveness of the various measures used is also essential.

Three confidentiality problems that could occur in telemedical practice include improper disclosure, improper forwarding, and unauthorized access. These can be translated as leaving records and medical data on a visible or easily accessible screen, forwarding the records to an

inappropriate party and failing to protect the records with an encryption mechanism. The latter would permit a computer hacker to access privileged materials. Simple ways to ensure reasonable security include a) just being careful, b) filing addition and deletion security icons c) using electronic audit trails d) immediately inactivating passwords of personnel who have relocated ,and ascertaining that one is sending information to the correct address and that the authorized user will be receiving it on the other end, by utilizing encryption and a return receipt.

Organizations should protect their cross-site transfer of health information using mechanisms that offer a level of protection appropriate to (1) the clinical content of the interaction and (2) the communication method selected to carry out the exchange. For example, based on the perceived sensitivity of the information, an organization using or sending data over public systems or networks might consider using either encryption application systems that have been designed to protect processed information, or Virtual Private Networks. When exchanging sensitive data with web sites, an organization or individual might elect to use the Secure Socket Layer protocol. Organizations should monitor effectiveness of the technical measures in use to protect information at each site and in the communications environment connecting them by regularly conducting vulnerability analyses to ensure their methods are not outdated

8.10 Building a Secure Critical Information Infrastructure

Commencing with Risk Assessment, Vulnerability Assessment and Penetration Testing an Information Security Policy and enforcement needs to be put in place. Periodic Risk Assessment evaluation of the operational environment, will identify procedure and technology based weaknesses. Risk Assessment and Management includes risk identification, risk analysis and risk evaluation. The Security Policy should cover Data Classification Policy and controls and include a Breach strategy assumption (Protect, Detect, Respond and Recover). Timely upgradation of technology should be a pre requisite. Network Security Architecture, Baselining, IT Asset Management, Domain Design, Deployment and Management, Group policies, Central patch management and security updates, end point security and hardening and server hardening also need to be in place. The infrastructure should also include implementation of PKI (A public key infrastructure is a set of roles, policies, and procedures needed to create, manage, distribute, use, store, and revoke digital certificates and manage public-key encryption) and DRMS (Digital Rights Management System). Various access control technologies are utilised to restrict usage of proprietary hardware and copyrighted works. Data Classification. Secure eMail, use of Digital Signatures, Advanced Threat Analytics, Application Whitelisting and Security, Enterprise nagement, and a BYOD Policy is also essential. Equal importance needs to be given to Change Management.

Regular vulnerability assessments will identify potential weaknesses in the technical infrastructure. Intrusion detection systems will identify inappropriate system access and alert site authorities to potential security problems. New technologies will eventually widely improve the ability to electronically record, store, transfer and share medical data. Policy issues regarding security of distributed electronic patient records have been studied. Dissimilar goals and expectations could result in security flaws. To find a common algorithm, strong enough to be safe and compliant with the law is indeed a challenge. Security issues are

numerous and of primordial importance in telehealth. Circumventing them is one of the key points for success of telehealth. Most of these issues can be addressed by cryptographic services and use of Public Key Instruction. Lack of standardization is a major drawback.

8.11 Security Challenges in Deployment of eHealth

- Users expect to be able to work in any location and have access to all their work resources.
- Increasing availability of new devices is eroding standards based approach to ***IT***. Deploying and managing applications across multiple platforms is difficult. Users need to be productive while maintaining compliance and reducing risk. Management, Access and Protection needs to be kept in mind while formulating a security platform.
- The security platform has to deliver a unified application and device management on premises and in the cloud.
- End users want and need new ways to work with consistent access to corporate resources on devices of their choice. Attackers see in this diversified approach an opportunity. Organisations therefore need to find balance.
- Protection of Critical Information and managing risk.

8.12 Specific Methods for Implementation of Security in eHealth

Security measures commonly employed include the use of firewalls, Virtual Private Network, Encryption, Biometrics, Public Key Instruction, Digital Signatures, Perimeter Defence mechanisms and Restricted Access Controls. Security Policies are necessary as is implementation of Accuracy, Authentication, Authorization, Anonymisation, Accuracy, Integrity, Privacy, Certification and Reliability. Even data auto destruction has been suggested as a security measure if there is evidence of attempt to alter (voluntarily or accidentally), theft disclosure or any improper use. Other protective measures include watermarking of document as a possible solution against cyber plagiarism. Standards, social, cultural, technological, legal, economic issues and the role of regulatory agencies will have to be considered before enforcing security measures. Many issues can be addressed by cryptographic services and use of PKI. It has also become important for healthcare providers to consider patient privacy and data security in the utilization of patient data, especially where such information has stigmatizing consequences

Security issues relating to increased risk of improper disclosure of records, breach of confidentiality, access to records, alteration or elimination of records from a remote site, vulnerability of computer-stored data to accidental erasure, and methods of ensuring verification of the above need to be addressed. Issues relating to data security: privacy, *i.e.* who can access the data; authenticity, *i.e.* who sends the data; and integrity, *i.e.* has the data been altered during its transmission through public networks are crucial. It is suggested that the first two issues are the responsibility of the data centre or the Information Technology Services of both the sender and receiver. Privacy and authenticity can be resolved by using various levels of passwords, based on a balance between convenience and cost. Encryption may help protect the data. Data protection and information security have often been viewed as possible constraints in the effective implementation and widespread use of telemedicine. The

complexities in a eHealth system include the large number of players and the dynamic constant changes taking place. “Manware” - user aspects of the system – also needs standardizing like hardware and software ! If goals and expectations are not similar security flaws could arise. Rules prohibit unauthorized transfer of medical records and medical history as misuse of sensitive information. *Electronic communications could be intercepted by people outside the care delivery domain* and are subject to interception—both internally at the locations participating in telemedicine/telehealth interactions and externally during transfer of information between locations

8.13 Digital documents

For most documents, authenticity is bound to the presence of an authorized handwritten signature. To find the equivalent of a handwritten signature for a digital document is a difficult problem. The receiver should be able to verify that the issuer is really who he/ she claims to be. The issuer should not be able to subsequently refute the document. The receiver, or any third party, cannot have created the document. A date stamp of the document creation is recorded. Asymmetric public-key infrastructure (PKI) cryptography fulfils the above needs but no PKI standard is universally recognized. Many countries have an Electronic Signatures and Records Act for recognising the validity of a digital signature.

8.14 Biometrics

Biometrics as a security measure has a strong appeal among many users. It is considered an innovative and next-generation technology measure. However, some patients may not be able to provide the requisite biometric characteristic due to physical or mental ailment. In emergencies, confidential medical data may have to be accessed by the health care provider, when the patient is not in a position to use the biometric password. Any discussion on the use of biometrics in e-health and telemedicine applications must include an examination of possible health and safety issues, from the user’s standpoint. In e-health applications, the proper use of biometrics necessarily involves a trade-off between technical and legal issues. A series of agreements or codes of conduct must be created to account for the lack of explicit rules for data protection. For e.g. retinal scanning, a biometric tool may reveal advanced diabetes and hypertension – sensitive personal information. However it has been argued that the retinal pattern will not reveal a specific diagnosis

8.15 PHI (Protected Health Information)

A PHI requirement in procedure documentation and job descriptions and reminding staff of their responsibilities through training/retraining has been recommended. Staff sign PHI confidentiality agreements with the organization. PHI is part of Business Associate Agreements, with other organizations that provide services in telemedicine. This will orient non-clinical staff members to a privacy culture, while also serving as a useful reminder to the clinical staff. Organizations should ensure that the technologies employed for processing PHI can be configured to provide the level of protection required for a telemedicine/ telehealth environment. These technological solutions should be cost effective and not interfere with the quality of data storage or communications. To prevent equipment-based sources of exposure,

organizations should consider denying PHI access to systems outside their direct control (e.g. laptops, PDA, and office desktops that might be shared with individuals not authorized to access the organization's data.

8.16 Industry Trends and Cyber Security Impact

Smartphones and tablets are placing information in the pockets of a billion global consumers. The world's mobile worker population would have reached 1.3 billion constituting over 37% of total workforce. Millennials will make up 75% of the American workforce by 2025. 65% of companies will be deploying at least one social software tool. Over 90% of new apps are currently distributed or deployed on clouds. 80% of organizations are either using or investigating cloud computing solutions. Digital content is in the range of 10 zetabytes with 80% growth of unstructured data predicted over the next five years. Malicious software is growing steadily with exponential Growth of ID's, 250% rise in Mobile Malware. Cyberattacks are more sophisticated with data theft and insider leaks. At least 77 Million user accounts have been stolen. Business Impact is an anticipated $165B Cumulative Cybersecurity spend by 2023. In Feb 2016 Credit / Debit Card details of 100,000 Britons were for sale on the internet.

According to a KPMG Report sectors facing increased cyberthreat include Financial services & Insurance, Pharmaceuticals and chemicals, Oil, Gas and utilities, IT and ITeS, telecom and media, Government ,Consumer and industrial goods/ Infrastructure and construction. *Interestingly healthcare is not mentioned*. A KPMG India Cybercrime survey in 2015 revealed that 65% of respondents opined that email servers were likely targets for cybercrime. End user systems (Desktops /laptops /mobiles),web servers, Enterprise Resource Planning Systems, File servers, Supervisory Control and Data Acquisition (SCADA) systems were also targeted. Phishing attacks targeted at email systems to defraud companies by redirecting foreign remittances/payments to money accounts of hackers,were not directed at healh care systems.

8.17 Cloud Model and Security

To start with, a proactive approach needs to be taken, against the expanding threat landscape in this sector.. With over a million servers in data centers around the world, security needs to be embedded in systems and software (SDL). Deep understanding of new threats and attack vectors is required. Specific attention needs to be paid to the following : *Assume breach" strategy , Incident response team working 24/7 ,Centralized monitoring and logging, Up-to-date software and patch management, Sophisticated intrusion detection controls, Anti-virus, anti-malware and Best-in-class security professionals*. Responsibility for Security is based on the type of Cloud Service eg Software as a service SaaS, Platform as a service PaaS, Logging as a service LaaS and On-premises software On-prem. Responsibility covers among others data governance and rights management, Client endpoints, account and access management, identity and directory infrastructure, Application, Network controls, operating systems, physical hosts, physical network and physical data centers.

8.18 Illustrations of Health Related Breaches In Security

- Major security breaches in the UK in 2009 and 2011 involved the loss of tens of thousands of National Health Service ('NHS') patient records.
- In the UK in 2009 the then Labour Government had devised a plan to allege that the leader of the Opposition party had suffered from a sexually transmitted disease. This was at a time when the UK Government was considering a National Health Record System.
- The Canadian Privacy Commissioner investigated how a cabinet minister's briefing notes included the medical and financial information of a critic of the Government's Veterans Affairs, including part of a psychiatrist's report. The individual later discovered that this information had been accessed by hundreds of federal bureaucrats.
- On August 3, 2016, Rainbow Children's Clinic was the victim of a hacker who accessed its computer system and then launched a ransom ware attack that began encrypting data stored on the Clinic's servers. The computer system was shut down immediately to prevent loss of patient information, and the Clinic immediately began an investigation. Rainbow Children's Clinic retained an independent computer forensic expert to assist, and through the investigation, the Clinic discovered that some patient records have been irretrievably deleted. The records that have potentially been impacted may include patient's names, addresses, dates of birth, Social Security numbers, and medical information. In addition, the impacted records may also include personal information regarding patients' payment guarantors, including guarantors' names, addresses, Social Security numbers, and medical payment information Rainbow Children's Clinic in Texas was hacked and patient records deleted.
- Johnson & Johnson has warned diabetes patients and doctors that a particular type of its insulin pumps is vulnerable to cyber hacking. A hacker in close proximity to the OneTouch Ping insulin pump system could use sophisticated equipment to find the unencrypted radio signal used by the device and program the pump to supply insulin." The risk to patients is extremely, extremely low," said Brian Levy, chief medical officer of J & J's diabetes-care business. "The more important thing is people need to use their meters and pumps because this is an important part of their health care.".J & J's Animas unit has sold 114,000 of the OneTouch Ping systems in the U.S. and Canada, mostly for Type 1 diabetes patients
- Researchers recently released a series of You tube videos outlining in details the means by which hackers could take control of monitoring equipment and either turn it off, or deliver a defibrillation charge to a patient who didn't need one, essentially shocking their heart at-will. Worse, the hacker could opt to leave the defibrillator running, essentially giving the patient a continuous, ongoing shock until death occurred. Vulnerability of certain pacemakers has been reported . So-called "smart" devices are notoriously bad when it comes to digital security. High profile cases have been reported in which significant damage has been done as equipment manufacturers did not incorporate reasonable security measures in the equipment they sold.
- A report on October 13 2016 reveals that even data like scans of patient X-rays have a monetary value to the right buyer. The story quotes John Halamka, the Chief Information Officer at Beth Israel Deaconess Hospital in Boston, describing an

incident that occurred after a contractor accidentally connected an unpatched medical records server to the Internet in order to upload a new firmware version, to the device. The technician went to lunch, leaving the system connected, on return found the medical records system crawling with malware. A subsequent analysis found that some 2,000 patient x-ray images from the machine had been downloaded to a system located in China.

- A total of 246,876 U.S. healthcare patient records were breached in Sep 2016 alone, according to data gathered by tech firm Protenus. The report finds that a significant portion of recent breaches were caused by insiders rather than external cyberattacks like ransomware, a malware variant that has become nearly synonymous with the larger healthcare industry
- In the biggest *Distributed Denial-of-services* attack ever seen, a botnet comprising 145,000 hacked Internet-of-Things devices, took aim at a European web host in September 2016 flooding it with a data deluge that at times exceeded one terabit per second. The attack ushers in a dangerous new era for data security and system uptime, experts said, and could pose dramatic new risks for EHRs and other hospital IT systems.

8.19 Conclusions

Most health care providers, health administrators and the hundreds of thousands employed in the health care industry need to be informed about privacy and security issues in electronic transfer of health data. Social, ethical and legal solutions can never ever keep up with technology. The demand for security should also come from the end users, rather than be imposed from above. At the same time a premature hype on privacy and security matters may actually thwart the growth and development of telemedicine. Privacy laws should be enforced stringently only when we are on the way to reaching the critical mass necessary for a successful take off . Pilot and proof of concept validation studies deploying telehealth have been completed. We now need to put in place rugged telehealth systems catering to tens of thousands, in suburban and rural India, incorporating reasonable security and privacy measures which will not be counter productive. The author, a non IT professional. is viewing this topic from an end user's perspective. Though more questions are asked than answers provided the article summarises the various issues and provide the basis for the interested reader to delve deeper into the problem. The references cited for additional reading will also be helpful. The article by itself probably would not at this time provide detailed policy suggestions or recommendations though a general road map is indicated.

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Appendix 1

MINISTRY OF COMMUNICATIONS AND INFORMATION TECHNOLOGY (Department of Information Technology) NOTIFICATION New Delhi, 11th April, 2011

G.S.R. 313(E).—In exercise of the powers conferred by clause (ob) of sub- section (2) of section 87 read with section 43A of the Information Technology Act, 2000 (21 of 2000), the Central Government hereby makes the following rules, namely.

1. **Short title and commencement —** (1) These rules may be called the Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011.
2. **Sensitive personal data or information.—** Sensitive personal data or information of a person means such personal information which consists of information relating to;—
3. medical records and history;

Body corporate to provide policy for privacy and disclosure of information: The body corporate or any person who on behalf of body corporate collects, receives, possess, stores, deals or handle information of provider of information, shall provide a privacy policy for handling of or dealing in personal information including sensitive personal data or information and ensure that the same are available for view by such providers of information who has provided such information under lawful contract.

Reasonable Security Practices and Procedures

1. A body corporate or a person on its behalf shall be considered to have complied with reasonable security practices and procedures, if they have implemented such security practices and standards and have a comprehensive documented information security programme and information security policies that contain managerial, technical, operational and physical security control measures that are commensurate with the information assets being protected with the nature of business. In the event of an information security breach, the body corporate or a person on its behalf shall be required to demonstrate, as and when called upon to do so by the agency mandated under the law, that they have implemented security control measures as per their documented information security programme and information security policies.
2. The international Standard IS/ISO/IEC 27001 on "Information Technology - Security Techniques - Information Security Management System - Requirements" is one such standard referred to in sub-rule (1).
3. The audit of reasonable security practices and procedures shall be carried cut by an auditor at least once a year or as and when the body corporate or a person on its behalf undertake significant upgradation of its process and computer resource.

9 Suggested Legal Framework for Telemedicine in India

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9.1 Introduction

Healthcare practice in India is far from satisfactory. Lack of basic infrastructure and limited social awareness has created issues in accepting technical advancements to telemedicine practice in India. While we are catching up with technical advancements, a comprehensive legislation in this new emerging area is essential. The perceived hindrances are not insurmountable; focused work can overcome initial teething troubles. The literature surrounding the subject is abundant, nevertheless, more research will create space for better learning opportunities. This work aims at suggesting reforms, with specific focus areas of work in the practice of telehealth and proposes a legal framework and roadmap for the implementation and growth of Telemedicine/eHealth in India.

Telehealth stresses on the critical factor of 'distance', linking the patients and doctors. Grappling with technology, it seeks advancement in healthcare delivery and is an innovative framework utilizing effective and ethical practice. Telemedicine is a rapidly growing application of clinical health care where health information pertaining to health is transferred across various telecommunication channels, for various health practices and procedures. Telemedicine can be demonstrated in a simple fashion by a telephone call involving two health professionals consulting each other, and yet can be complex in its understanding where satellite technology and video-conferencing is used to establish a real time consultation session. The practice is not restricted to real time sessions, but also includes the exchange of electronic mails in a store and forward milieu.

Telemedicine is not entirely new, the concept however has taken decades to seep into the mainstream, as a health care delivery system. As is the case with any new innovation, it is not just the economic viability, but also the social acceptance of the concept which needs to be achieved, for the concept to become a practice. In developing countries, lack of infrastructure; lack of technical and capital resources; and, absence of rules, regulations, and, a comprehensive legal framework protracts the slow growth.

Technologies utilized in telemedicine have transcended the boundaries of time, culture, and geography. Opportunities presented by telemedicine are significant in regions with reduced healthcare infrastructure. In our attempt to correctly measure the reach of telemedicine, we need to initially assess the risks that need to be overcome to realize the bigger picture.

The terms Telemedicine, Telehealth, eHealth and Digital health are used interchangeably as they all refer to the delivery of virtual healthcare bridging the urban rural health divide. The

scenario in developed countries and developing countries are reviewed before going into the specific aspects of legal and regulatory framework in India.

9.2 Developed Countries

Developed countries spend a higher percentage of their GDP on mostly aided by using technology. Hence, there is considerable investment in "Technology for the Health Care" sector. With paper records shifting to digital records, sharing of records and ease and efficiency of patient care has increased multi fold. Most telemedicine services, focusing primarily on diagnosis and clinical management systems, are offered routinely in industrialized regions including, but not limited to the United Kingdom, Scandinavia, North America, and Australia.

Developed countries have realized the existence of sensitive data in health care necessitating laws for their regulation. The US *Health Insurance Portability and Accountability Act* of 1996 and the Privacy Rule, has been used as a biblical reference by many body corporates and, stakeholders involved in formulating similar laws for their respective processes. An all-inclusive law, HIPAA, has helped establish procedural norms, and clear definitions on the issues involved in information collection and sharing.

In Europe, there is considerable clarity in respect of laws governing and regulating the practice of telemedicine. Telemedicine has been defined as "*the provision of healthcare services, through the use of ICT, in situations where the healthcare professional and the patient (or two health professionals) are not in the same physical location. It involves secure transmission of medical data and information, through text, sound, images or other forms needed for the prevention, diagnosis, treatment and follow-up of patients".* Within the definition itself lies the emphasis made by the legislators in adopting methods of "secure transmission" of the medical data and information pertaining to an individual.

Developed countries are closer to implementing the state of the art technology, consequently, the laws will be more relevant and appropriate to rapidly evolving technology.

9.3 Developing Countries

In developing countries, inconsistencies stem right from within the healthcare system. The presence of multiple heterogeneous systems, makes the infrastructure a massive bubble of apprehensions and ambiguity. To add to this, health information of patients is not necessarily secure. While developed countries are shifting their focus towards protection of privacy and security issues in handling and management of patient data, developing countries are still attempting to achieve technical goals.

Various studies and reports suggest that partnerships between developed and developing countries could be mutually beneficial Areas of such cooperation include, rural health service delivery; innovation in mobile phone use; skill building; health financing; and low technology simulation training.

As per the WHO Report, very few countries have a sufficiently strong and effective health information system in place for achieving the United Nations Millennium Development Goals (MDGs). Information obtained through a robust health information system needs to be put to good use. Boom in mobile health in developing countries have reportedly created innovation hubs in many countries including Kenya, Uganda, Rwanda, India, and South Africa. Campaigns using mobiles would assist in improved rural healthcare, and bridge gaps in disaster preparedness and improve response. This would lead to improved quality of care, lower costs and better opportunities for healthcare providers resulting in economic growth.

9.4 India

Telemedicine can be of great help to nations like India with a large rural population and dispersed locations. Reduced costs in patient transport, and significant improvement in patient care can be achieved by embracing Telemedicine. Inadequate facilities and lack of specialist doctors in remote areas, can be addressed through telemedicine.

There have been many efforts taken at various levels in the public and private sectors to understand the scope and reach of quality healthcare. They include defining the concepts and elucidating the standards required for hardware, software and clinical devices including security aspects, when introducing telemedicine/ telehealth.

Objectives: promoting growth of Telemedicine, increasing availability and quality of medical services, identifying mechanisms for protecting the privacy and confidentiality of individuals' health data, and eventually to provide a framework for interoperability and scalability across Telemedicine services.

The Report of the EMR Standards committee, observed that privacy and confidentiality of the user is a prime focus area. This resulted in a circular from the Government of India introducing a uniform system for maintenance of Electronic Medical Records/ Electronic Health Records (EMR/ EHR) by Hospitals and healthcare providers in the country.

The EHR Standards also stressed on the protection of sensitive data, and acknowledged benefits of promoting interoperability. Interoperability is an uphill task due to the existence of heterogeneous systems. The National Health Policy, 2002, also envisaged an increased spread of *Information Technology* in the health sector, for better accessibility in remote areas, and for provision of quality patient care services.

Started in 2000, the teleconsultation conducted by Apollo Hospitals, Aragonda, is the first of its kind in India, and has been described as a milestone in Rural Healthcare. It also served as a pilot project for the Indian Space Research Organization (ISRO), linking Apollo Hospital at Chennai with the Apollo Rural Hospital at Aragonda village. The telemedicine program in India, spearheaded by the Indian Space Research Organization, using Satellite Communication (SatCom) has resulted in substantial growth of telemedicine networks with the collaborative efforts of various medical research organizations, trust hospitals, NGOs and state governments.

These programmes are also increasingly involving themselves to increase social acceptance of the concept of a physician sitting miles away from the patient and prescribe the course of treatment.

9.5 Stakeholders and Issues

A healthcare system has many stakeholders, leading to several issues. Some of these issues have been discussed as below.

9.5.1 Stakeholders

Healthcare Professionals/ Institutions, Insurance Agencies or Third Party Administrators, Government, Private Healthcare Systems, and NGOs/ Non Profit Organizations, are all stakeholders in a healthcare system with the patient as the primary subject. Their roles would be as follows 1) Patient, is the recipient of care and benefits; 2) Government, is the regulator and benefactor; 3) the Healthcare Professional is the care giver; and, 4) the Insurance Agency or Third Party Administrators, are the benefactors and coordinators. 5) IT, Hardware and connectivity service providers are also important in this context as uninterrupted quality service through secured mode of transmission of the medical data to the experts is the crux of the scheme.

9.6 Issues to be Considered

With a nearly non-existent Universal Healthcare system, patients suffer due to economic travails. With a large under-privileged population, all patients cannot subscribe to private health insurance plans. In the absence of a uniform national health care system, it becomes expensive to subscribe to a private insurance plan, or pay out of pocket to private service providers or travel long distances to public health centers, where the waiting time is considerable.

Another major concern is the fact that there are no intelligible criteria for prescribing classes when it comes to healthcare benefits. In India, we do not see a gradation in the population, to enable the government to administer its benefits to the vulnerable population in an efficient and structured manner. Whereas in the US Medicaid and Medicare, are designed specifically for families with limited incomes and the elderly respectively, no such processes are in place here, in India

The US population has been classified to ensure that effective care coordination can be ensured, along with interoperability. A uniform system housing all the medical information of a demography, makes ensuring quality patient care relatively easier. Care coordination involves follow up of patients leading to quality patient care. Interoperability ensures transfer of patient data from one healthcare professional to another with ease and convenience without loss of information.

Albeit, various moot points have been addressed by the existing laws, sensitive cross-border issues like the legality of a physician in India giving an opinion for a patient outside India and *vice versa* is yet to be discussed and specifically addressed.

9.6.1 Legal Issues

The most basic question which arises when it comes to legality of the practice of telemedicine is the validity of the program. It is a moot point that when a prescription is defined as "*to be in writing and be signed by the person giving it with his usual signature and be dated by him*", whether prescriptions sent through electronic mails by a physician in the course of a teleconsultation is legal?

Some of the legal issues which need to be specifically addressed in the light of practice of telemedicine, include but are not limited to: medical licensure; medical malpractice and liability; telehealth and prescriptions; informed consent laws and privacy and security laws. From the perspective of the recipient of the treatment, the teleconsultation must also conform to the health insurance plans that he/she has subscribed to. This is to ensure that the plan acknowledges and reimburses the teleconsultations initiated by the beneficiary. Reimbursement for tele consults could also be considered to be a medico legal issue.

With flow of such sensitive information, the stakeholders involved in collecting, handling, retaining and transferring such sensitive personal information, also need to act in accordance with the laws of the nations where such data flows from, is retained, and further disbursed. Indian law governs different aspects of medical practice and information security and the existing provisions of law seem adequate to confront any potential legal issues arising in this context. It is to be noted that consequent to government initiatives and with growing involvement of diverse stakeholders, including private and commercial ones, the need for change/redefinition of the laws, exclusively for Telemedicine is imminent.

All issues plaguing the widespread use of telemedicine are truly global in nature, though some might be having more significance in developing countries. A well-defined *standard of care*, is an essential element of medical jurisprudence, this needs to be retained in the practice of telemedicine. As the practice enhances the reach of the practitioner, enabling better diagnosis and patient care, it would lead to better standard of care.

In cases of professional negligence and, medical malpractice, the relationship of the caregiver and the recipient of such care does not change because of the "distance" factor. Where the caregiver fails in his/her duty of care because of the doctor- patient relationship, he/she shall face the liabilities arising out of his/her action or inaction. Matters of shared responsibility become a very tricky issue with involvement of the provider of the infrastructure, the host, and in some instances the local doctor, when there is a physician present at the physical location of the patient.

9.6.2 Domestic and Cross Border Issues

Issues of licensure can come to play because licensure is territorial in nature. So, while a doctor who is registered with the Medical Council of India can practice anywhere in India, he cannot practice outside India. In case of Telemedicine, at present there is no governing council or specific regulatory authority at the domestic or global level to issue licenses for international practice. Even if national laws authorize such practice, it should bear international approval.

While *the Indian Information Technology Act, 2000*, and the rules thereto, address the rules governing sensitive personal information in general terms, there is no specific legislation addressing the issues pertaining to the health sector.

Apart from standards and guidelines issued by the Ministry of IT, and various working committees, which prescribe the technical standards of use; it is proposed that there is also a growing need to have regulations, and frameworks in place to mandate technical understanding.

Health Information in India is not yet sorted and stored on a uniform system, unlike in the west, where a comprehensive Health Information System is up and running. In pursuance of an effective *Health Information System,* the Indian government should also aim at having a system where sharing information over a uniform portal, across a spectrum of heterogeneous systems (prevalent in India) is feasible. Not only does interoperability facilitate better care, coordination and patient care, it also assists telemedicine in its outreach, portability and reliability.

An important facet of e-Health, Telesurgery, also has not found much traction in the country. Owing to the lack of a legal structure that specifically addresses the issues concerning cross-border physician-specialist-patient relationships, the practice is yet to find its roots in the country. It is a highly technical, complicated process requiring compliance with the law.

9.7 Comprehensive Framework: The NEED and A PROPOSAL

Health sector is one of the grossly overlooked sectors in the country. While telemedicine is slowly being accepted, risks need to be evaluated accurately. Today, it is assumed that existing laws would suffice for tomorrow, but that is not always the case. Yesterday's dream becomes today's invention and tomorrow's necessity. It is safe to assume that since we progressed from enacting laws governing roads, to laws governing the skies, and ultimately to laws governing outer space; the laws for today will be outdated with new inventions, more involvement, and dynamic issues.

A system involving multiple stakeholders is bound to be plagued with a plethora of legal issues. These issues arising out of intermingling need to be addressed.

As technology grows, the law must develop and mature simultaneously, maintaining pace with technological developments. The dire need for a comprehensive legal framework, has been stressed by many in various writings and discussions.

As we propose, a legal and regulatory framework for Telemedicine in India, needs to cover: 1) Defining the Patient – Physician (Doctor) Relationship; 2) Informed Consent; 3) Inter-jurisdictional Application of the practice and its implications; 4) Intelligible differentia; and, 5) Establishment of an Impartial Body exclusively governing the practice of telemedicine, for advancing **Telemedicine for Universal Healthcare** and for **Implementation and Growth of Digital/ eHealth in India**. The framework highlights the areas that need to be considered in bringing legal enactment in this area but does not specify the operational level of details, which is the mandate of the legislators. The framework shows

several aspects and criteria to be considered, and a path forward. The envisaged framework must include the following, but not limited to:

1. Establishing the Patient – Physician relationship: A relationship which is so zealously guarded due to the inherent standard of care and duty of care borne by one party, must be categorically defined in the legislation which is envisaged. To achieve the trust factor in the relationship, both the caregiver and the recipient must become acquainted with one another. In tele consultation, it is only when such a connection has been established in good faith, and on credible grounds, can the relationship said to have begun. Currently, a categorical definition of patient-physician relationship in respect of telemedicine is not available. Nature of the relationship will also vary with changes in technology deployed, depending on contextual dynamics. The relationship needs to be precisely defined, as both the caregiver and the recipient of such care, are required to present their credentials and must also establish acquaintance to ensure that the fiduciary relationship can be enforced as such.
2. Definitions: Telemedicine, telemedicine technologies, health care system, stakeholders, informed consent, reimbursement, and other terms should be specifically defined under the enactment.
3. Informed Consent: A mere definition of the term does not suffice on this highly sensitive topic. The patient must always be aware of the information flowing from him/her, the nature, usage, purpose, and retention of such information must be properly communicated, ensuring that it is all understood by the patient. The patient should always have the prerogative to withhold information from third party transfers, and must also be aware of the credentials of the consulting physician. The present definitions have not been propounded for the specific utilization in terms of medicine and health, and as such the definition might require some tailoring to encompass the existing heterogeneous systems in its scope and ambit.
4. Privacy and Security Standards for EHR/ EMR: Along with the general laws in place, it is proposed that there must be a specific legislation focusing on the privacy and security standards which must be adhered to, in terms of telemedicine and telehealth services.
5. Inter-jurisdictional application: While discussing matters concerning distance, it is necessary that issues relating to international boundaries also be discussed. This will require global sanctions, and must engage more social, economic, and political dialogues at the level of nation states.
6. Liability: As the patient – physician relationship is a fiduciary relationship; the duty of care is much higher. Any dereliction in duty also involves grave liability. In case of an expert giving opinions, liability must extend only to that opinion and where the physician who carries out the instructions so coming from the expert, his/her liability should only take note of the action or the inaction. In other words, while the expert can be held liable to the extent of standard of care, the physician who has sought the expert's opinion can be liable in terms of violation of a duty of care. When liability is identified, it is proposed that provisions be also made for exemptions, in cases of technical failures, and to ensure that the accountability, *factors in* all the elements of telemedicine, and not just account for the conventional means of health practice. It is also to be noted that liabilities have to be defined in the light of intermingling of health care providers, and the flow of data which takes place there. There should also

be considerations in respect of fraud and misappropriation of patient information and health data.

7. Reimbursement: Specific amendments, and necessary principles must be set for the insurance agencies, third party administrators to acknowledge and accept patients who are referred for telemedicine and, telehealth services. The scope of such coverage, be it national or international, and the ceilings on such transactions, has to be codified and offered as part of a comprehensive structure. This will also help examine if there is any fraud or misappropriation committed, when acquainted health care providers are involved.
8. Professional and Ethical Standards: Once norms of practice have been established, it has to be ensured that all principles laid down are in conformity with existing professional norms of practice. Issues like defining prescriptions, and what must be clearly excluded from it must be considered.
9. Technical Standards: Along with technical standards of telemedicine technologies, it must also consider and take into account the technical understanding of the health care professionals..
10. Intelligible differentia: The enactment must identify the population which is most vulnerable, and stands to gain from cost saving telehealth programmes stressing on serving outreach programs. There is a need to bring changes by mandating universal health care.
11. **Establishment of an Impartial Body**, like Telemedicine Authority under State Medical Board for overseeing Telehealth Activities and to regulate telemedicine activities in the country are essential. The body should oversee among other activities the following:
    a. Body can comprise of Expert Panels: Health Care Professionals, Insurance/ Third Party Administrators, Technical Experts, Legal Professionals, Academicians remove caps
    b. Collaboration of Private and Public Entities
    c. Identifying vulnerable demography, disease control
    d. Licensing and training healthcare professionals in telehealth including competence to provide overseas tele consults.
    e. Conformity on standards set for the Insurance Agencies/ Third Party Administrators as applicable to telehealth activities
    f. Act as the instance of first appeal in matters peculiar only to Telehealth

Only licensing and adjudicating functions of the impartial body have been stressed. If the same body operates, licenses and regulates, there will be no separation of powers resulting in questionable results.

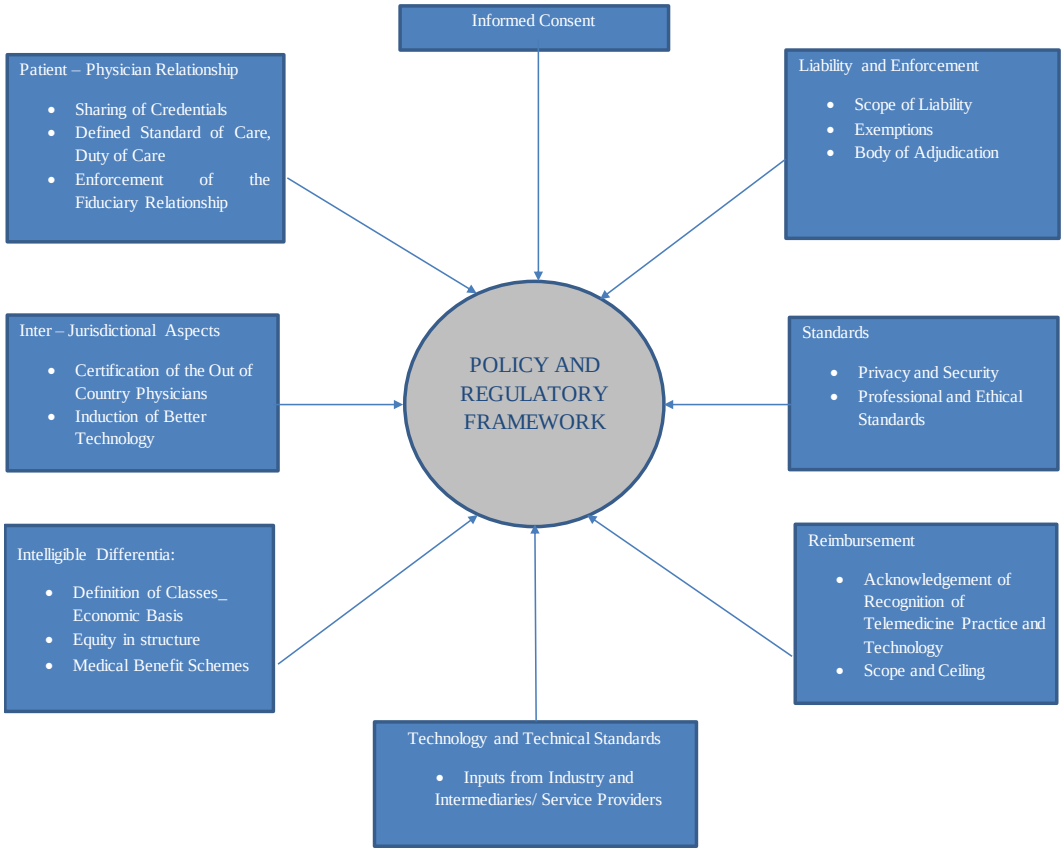


Figure 9.1 Suggested Legal and Regulatory Framework of Telemedicine/eHealth in India

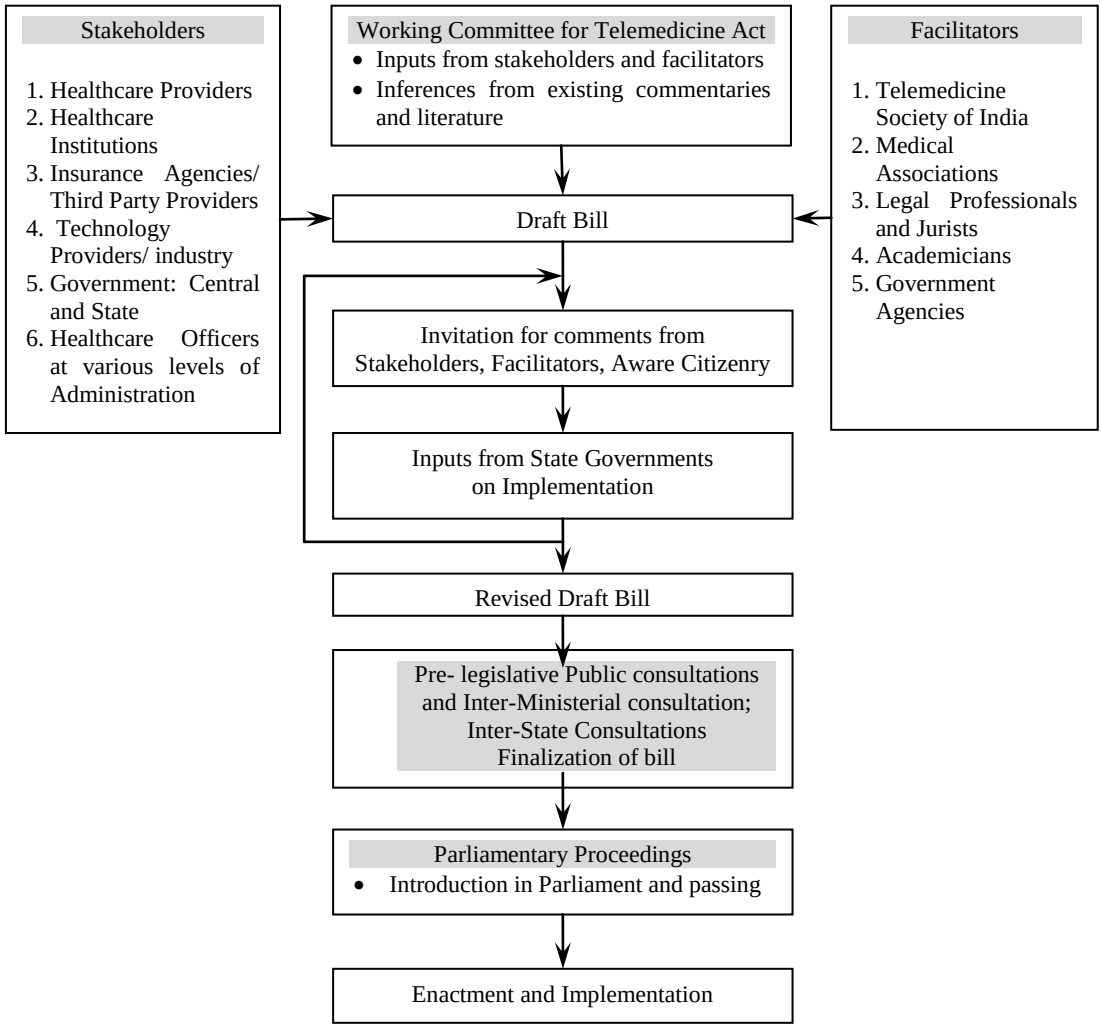
Relevant literature in the public domain, needs to be thoroughly reviewed. While this could be the basis, setting up a committee of experts to work on guiding principles will bring in more structural approval. As health is a state subject, combining this with various aspects of Information and Communication Technology, it is to be ensured that states cooperate with the central government on the legislation for deploying telemedicine across the country. The legal framework for Telemedicine in India can be summarized as shown in Fig. 9.1:

9.8 ROADMAP AHEAD

The above discussion and draft framework has brought out a multitude of aspects and dimensions to be considered and deliberated upon, while forming the legal and regulatory structure for India. The roadmap to finalize the same and implement is a demanding and challenging job. This is presented below.

All the potential stakeholders must be involved in the process of developing of the framework. Comments should be invited from all stakeholders, and enablers of the process.

This ensures that the outcome of these efforts represent the majority view and also gain societal approval.



The above flowchart gives an idea of what can be achieved with deliberation and informed contributions towards the framing and enactment of the legal framework to govern, regulate and promote telemedicine practice in India. The earlier outline which lays down the components and features of prospective legislation can be brought to fruition with collaborative efforts and interdisciplinary feedback.

One must note that the debate can never come to an end, as we progress towards better technology and increase in number and types of stake holders. Challenges will be perennial and answers have to be forthcoming to mitigate risks which come with such advancements.

Existing models of law, in the developed countries governing this focus area, need to be referred to in the initial framing phase. Organizations such as the Telemedicine Society of

India have committees in place which study and research on the issues that are likely to hinder growth in the sector. The increasing need, the expansion of practice, and the potential risks involved in the future, cannot be ignored anymore. They need to be addressed by the appropriate government wings. Advance actions in this respect, is preferable to worrying at a later stage.

Licensure and liability laws are in place in the United States Various States in the USA have enacted provisions where physicians are exposed to criminal and civil penalties, state disciplinary proceedings, and, sometimes denial of coverage under medical malpractice insurance policies. Analogies can be drawn from here, and integrated into our federal structure.

Issues relating to fraud committed over the web for e-prescription of drugs, not banned uniformly in all countries must also be considered while drafting the enactment.

As Health is a state subject, the central government needs to bring together all the states to unanimously, embrace the new practices and methods, for the benefit of its citizens. This long and tedious process must be initiated soon to ensure that when the problems actually come knocking it can be dealt with.

9.9 Conclusions

Today, we learn from western countries, when introducing laws on telehealth. This needs to be formulated specifically for limited technology resources and a vast rural population in a developing country.

New changes in the socio-political and socio-economic scenario will require new technical and legal regimes. Social acceptance is equally necessary to enter into this new transition. Successful pilot projects can also be used for guidance in the way forward.

There have been no legal cases in the Telemedicine practice in India in the last 16 years in spite of increasing use of telehealth and lack of a legal framework. Nevertheless, prevention is always better than cure. Preventive steps need to be taken before a “test case’ comes to court.

Constant dialogues and collaborative efforts are necessary to realize and implement rules and regulations in the area of telehealth. To quote H Jackson Jr “*The best preparation for tomorrow, is doing your best today*.

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10 Healthcare IT Deployment and RoI

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Thesis: Across the world, hospitals are in a race to achieve modernization. Most of these hospitals are investing heavily on IT, and healthcare is set to become one of the key areas of IT spending in the years to come. Most of these IT drivers include the fast-growing promise of eHealth, symbolized by an end to end patient administration system in the form of Hospital Information Management System (HIMS); clinical information systems in the form of Electronic Medical Record (EMR) to digitally recorded and stored laboratory and imaging systems in the form of Laboratory Information Management Systems (LIMS) and Patient Archiving & Communication Systems (PACS) respectively. Apart from these, new equipment and technologies (from patient tracking using RFID, to patient engagement and patient monitors) are emerging by the day. While eHealth simply means increasing the reach of healthcare service delivery, electronically and digitally via secure networks: the above described forms of eHealth drivers (HMIS, EMR, etc.) will be the cornerstone of such a distributed healthcare architecture. Additionally, these individual systems need to be integrated with the still functional 'old' IT backbone in a hospital - and the wider healthcare environment. While doing so, a hospital may entail huge costs in terms of faulty patient accounting data to unavailability of accurate patient information system at the time of clinical decision making, which might even lead to irreplaceable loss of human life. Most of these new age technology drivers are not only high on cost, in terms of their implementation and support, but at the same time they are bound to entail mini-revolutions in their efficiency. This brings the hospital leaders across the world to harbor doubts about the return of investment (RoI) from these IT systems. At a time when the average hospital margins are stagnant at 2%, the prospect of investing in another tidal wave of technologies has them, asking some tough questions about RoI. Will the new technologies prove their worth? Are the RoI predictions of vendors to be trusted? Under such conditions, IT is clearly the engine for future shape of healthcare but question remains about how exactly these amounts spent in IT get channelized. This study aims to showcase how RoI can be evaluated for a hospital after the complete adoption of an integrated hospital IT system.

Argument: Many healthcare institutions across India and the globe are making huge investments in IT, but the RoI from this is always objective and is highly questionable owing to rise in expenses incurred due to their adoption against the desirable returns they provide. Firstly, as there is a higher imperative for zero learning curve in *Healthcare IT*, it becomes a major reason for resistance to change in the adoption of IT and wider healthcare management profession. Another question which faces healthcare managers and CIOs in particular is justifying investments in healthcare IT. Across the world, healthcare has always faced massive pressure for cost-containment and efficiency. As such, the spending of a hospital budget on IT systems or modernization project are neither small nor are considered to be highly significant

when compared to other spending heads of a hospital budget. It is therefore no surprise that issues of RoI confined to sectors like manufacturing and retail have begun steadily emerging in the field of Healthcare IT too.

10.1 Healthcare IT & RoI – Unique challenges

Measuring RoI in healthcare faces a host of unique challenges. These have to be first understood, accommodated and mastered to sell the concept of RoI itself – before making RoI the centerpiece of a case for an investment in healthcare IT.

Traditionally, RoI measures the financial impact of operating expenses against revenue gains from service delivery. If the latter exceed costs, RoI is positive and an investment is justified. In healthcare, however, benefits have so far been usually aimed at avoiding costs rather than increasing revenues. In many western healthcare systems, the enormous complexity of the healthcare payment system has resulted in making revenue measurement an unsurmountable task. This was, of course, not the case, when healthcare IT principally involved isolated applications, such as payment and invoicing, appointments scheduling, or even lab reporting.

In the past, while investing in devices such as CT scanners or PACS systems provided an instant revenue stream for a specific hospital, few facilities saw an EHR yielding 'measurable' revenues in less than 3-5 years; it thus stayed on the perceived cost side of the balance sheet. This is no longer the case, where hospitals are obliged under new national laws (eg: ARRA act in USA) to ensure that their IT systems are (or will become) interoperable. Failure to comply carries penalties, and this too is/will become a cost. In addition, a longer-running reorganization of healthcare (principally to unbundle specialties from general hospitals) has also been slowly but surely increasing the costs of non-interoperability. In the US, on the other hand, an almost perverse logic militated against increased IT. Senior officials from payers such as Medicare and Medicaid publicly noted that efficiency in services provision ensured higher payments in all sectors excepting healthcare.

10.2 Method

RoI in healthcare IT has key elements consisting of - : financial, patient care quality, business, infrastructure and safety & soundness. 'Patient Care Quality' straddles both 'functionality' and 'technology' whereas 'business' corresponds to 'management'. These are described below.

- **Financial RoI** in healthcare IT is measured in terms of cost savings from decreased staffing and resource requirements. Examples include automated PACS which reduces the need for data entry personnel for transcription, speech recognition devices which eliminate manual transcription by the radiologist, or appointment and treatment scheduling systems which reduce waiting times from order entry to procedure completion and reporting. IT systems which enhance throughputs and achieve scale efficiencies also fall under this heading.
- **Patient Care Quality** Efficiencies in the patient care quality range from IT systems which provide higher adherence to clinical protocols, enhance the speed of consultation, clinical documentation and decision making, and above all, reduce medical errors. More efficiency in simpler systems, such as call centers and hotlines, can also impact on both quality of care (and thereby on financial RoI).
- **Business:** Across the world, a growing measure of business RoI has been length of stay (LoS). This is now routinely monitored by hospital management to identify

overall business efficiency. The LoS indicator also correlates strongly with patient outcomes, with lower lengths of stay and quicker discharges - accompanied by a lower incidence of readmission. In addition, LoS is directly resulted to bed capacity and utilization rates, and this form of RoI is widely used across a whole range of sectors. Softer issues such as higher satisfaction on the part of healthcare professionals and patients, reduced waiting times and quicker information are also factored into business RoI. Indeed, hospitals in developed countries have already begun monitoring patient satisfaction via questionnaires, and such a practice – once formalized – will no doubt be brought into the matrix of RoI measurement.

- **Infrastructure:** Key metrics such as efficiencies and speed of implementing and running new systems and tools, system uptime, response time to resolve issues/outages, etc. should be defined and measured for RoI.
- **Safety & soundness:** Few metrics around protecting customer data and digital assets also form part of RoI measurement framework. Some of the key metrics measured here are number of threats detected and defended, number of privacy breaches, fraud losses, etc.
- Based on research, PwC has developed an index to measure and improve RoI from technology investments: the Technology Investment Fitment Index. TIFI consists of four key broader dimensions and inputs to these dimensions should come from client's focus areas and key performance metrics such as key elements (Financial RoI, Patient care quality, Business, Infrastructure and Safety & soundness) as described above.

Together, these dimensions should be the priorities for companies looking to make IT investments that can unlock greater value.

Alignment with differentiating capabilities	• Technology investments explicitly build differentiating capabilities that lead to growth and increased profit or reduced costs
Technical ability to execute	• The organization has — or can acquire — the technical strength to successfully implement large IT projects • The target technologies and technical capabilities align with the company's overall technology strategy and road map
Value generated relative to risk	• The company has identified the potential value it will generate through the IT investment • It also has clear insights regarding the executional, transitional, and operational risks
Operating model to sustain performance	• The business has the right organization and processes to adopt technology solutions • The IT function is set up to support, enhance, and scale the solution — in collaboration with business units — in the most cost-effective way

10.3 Conclusion

Numerous healthcare organizations have demonstrated that they recouped IT investment costs through a combination of increased revenue and reduced expenses. Using classic RoI calculation methodologies for a particular investment computed on increased revenue and reduced expenses may suggest that an organization won't recoup its investment. However, such methodologies need to be expanded to include intangible benefits such as customer satisfaction, easy access to information and enhanced patient quality. It is critical that healthcare organizations make every effort to consider all 3 - financial, patient care quality & business RoI resulting from their IT implementations. Existing literature broadly suggests that healthcare organizations may be able to recognize hard dollar benefits by eliminating costs associated with reduction of paper files, transcription costs and staffing. The literature also suggests that many healthcare organizations will also be able to yield greater revenues from enhanced billing practices that generate more accurate billing and increased payments. However, as healthcare organizations also see a reduction in duplicate testing and a more efficient use of clinical time, they may ultimately see a decrease in revenue. In the current healthcare climate, organizations are reimbursed based on the services provided and also by taking patient care outcomes into consideration. As a result of providing better care through the best use of IT, and changing payment models, healthcare organizations may experience a reduction in revenue. Finally, IT is viewed as a key component of measuring healthcare RoI, where executives must first understand how IT can be harnessed to jointly improve outcomes, reduce costs and generate new revenue.

11 Space Technology Enabled Information and Communication Technology Augmenting Healthcare Delivery in India

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11.1 Introduction

Space is no longer a "big boys club". Fifty-seven countries own and operate at least one satellite, while virtually everyone on Earth benefits from the services these orbiters provide (Kazuto,2014)The landscape of space activities and spacefaring nations has gone through an intense transformation in recent times as can be seen by an ever larger group of countries with different levels of satellite and launch capabilities emerging, as developers and exporters of space technologies capabilities. Except a select few, the budgetary and fiscal allocations of spacefaring nations has seen sustained increase, to reach new heights in technology and newer frontiers in applications. Investing in space technology results in economic growth and national development. Space assets serve as an economic multiplier and enabler for many other sectors, including transportation, banking, telecommunications, Internet services, healthcare, agriculture and energy among others.

Investments in space programmes are often justified by the scientific, technological, industrial and security capabilities they bring (OECD, 2011)..

Currently, approximately 1,000 active satellites provide considerable benefits that improve the world in many ways. Examples include efficient global navigation and transportation, essential communication services and daily weather forecasts. The benefits of space technology include providing valuable information to decision-makers and planners, for an informed decision making in development planning, natural resources monitoring and management, environment/climate protection and disaster mitigation and management

The last three decades of the 20th century have witnessed space technology finding increasing application and relevance in daily life. Space-based systems deliver information and services that protect lives and the environment, contribute to sustainable development planning, enhance prosperity and security, and stimulate industrial and economic development (UN OOSA/Vietnam, 2011).

11.2 Applying Space Technology beyond Its Original Intent

Once an exclusive resource, space-based technologies and their applications are now increasingly available to governments, businesses, civil society organizations and even extending to personal use.. From monitoring human rights violations and the impacts of climate change to helping people find the fastest way home, space technologies are being applied in unexpected and innovative ways (WEF, 2014).

Taking clue from the overall objectives of outer space for peaceful activities laid down by the UN OOSA, several countries have extended space technology and services to areas beyond the original intent. Launch vehicles, Satellites, Earth/Ground stations etc. are the direct space segment/related activities.

From inception, as per the vision of the father of the Indian Space Programme, Dr. Vikram Sarabhai, ISRO (Indian Space Research Organisation) has been following the objective of making available the benefits of space technology to the common man at grassroots level. ,. Similarly, NASA (National Aeronautics and Space Administration) is delivering on the mandate it received from Congress more than 50 years ago—to broadly disseminate its results for the benefit of all mankind (Doug, 2010). Many other space agencies and enterprises also continue to seek prospects to relate the benefits of space technology for the betterment of the human condition and our planet.

NASA invests in technologies and discoveries for the future, and in the process, delivers social and economic impacts that benefit the nation today . NASA works in areas directly affecting human health, life support and habitation systems, including portable life support systems; medical diagnosis and prognosis; air, water, and microbial sensors; and radiation mitigation with examples of down to earth applications including Synthetic biology, Telemedicine, Disaster preparedness and response, Environmental remediation (Tauri-NASA, 2013).

There are also many indirect and unforeseen benefits in the form of spinoff products useful for society at large. From the need to miniaturize electronics in the 1960s for NASA's Apollo programme, the space sector laid the foundation for the microelectronics revolution and, consequently, the development of modern computers. Space spin-offs are not always limited to high technology. They extend to applications in medicine, energy, food, textiles, agriculture and many other areas. The following table 11.1 lists a few examples of spin-offs and their origins relevant to healthcare (WEF Report, 2014).

Table 11.1Space Programme Technology and Commercial Spin-offs

	Product	Origin
•	Tumour tomography	NASA scanner for testing
•	Battery-powered surgical instruments	Apollo programme
•	Mammogram screening, plant photon-counting technology	Space telescope instruments
•	Skin cancer detection	ROSAT X-ray detection
•	Dental orthodontic spring	Space shape memory alloys
•	Early detection of cancerous cells	Microwave spectroscopy
•	Fresh water systems	International Space Station technology
•	Healthy Snacks	Space food

The Indian space programme has been pursuing a systematic and well defined policy for transfer of know-how of products / technologies developed by the Indian Space Centres. The objectives have been manifold, viz., to facilitate greater participation of Indian industries in various space projects, their applications in the commercial domain and to take benefit of

'spin-offs' of such technologies. ISRO transferred some space technologies that have helped the society at large including the following major ones:

- INSAT based Distress Alert Transmitter (DAT), for emergency message communication transmission for sea going vessels especially useful for fisherman
- Artificial Polyurethane (PU) Foot based on PU technology used in launch vehicles
- PEDCLEAN-A cleansing system useful for industrial and laboratory personnel
- Artificial Denture Material, ACRAMID used for fixed prosthodontic restoration when a tooth is lost.

India, US, Russia, Europe and Japan followed a variety of approaches to adopt for the successful transfer of technologies that impact innovative products and also valuable services for non-space applications like Telemedicine, Tele-education and rural services.

11.3 Healthcare delivery across geographies - Space Technology Tools

Health is defined as "A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity" (WHO, 1946), wherein, physical health is directly dependent upon the facilities and facilitators available within the reach of the needy. Health is an imperative need for human resource development and a universal desire – with varied levels in one's life span. Alma Ata Declaration (1978) articulates "To achieve the goal of health for all, global health agencies pledged to work toward meeting people's basic health needs through a comprehensive approach called "Primary Healthcare". Unfortunately this penetration of healthcare at primary levels is not achieved and many problems like shortage of hospitals, physicians and nurses along with geographical limitations and access hinder the realization of such a goal.

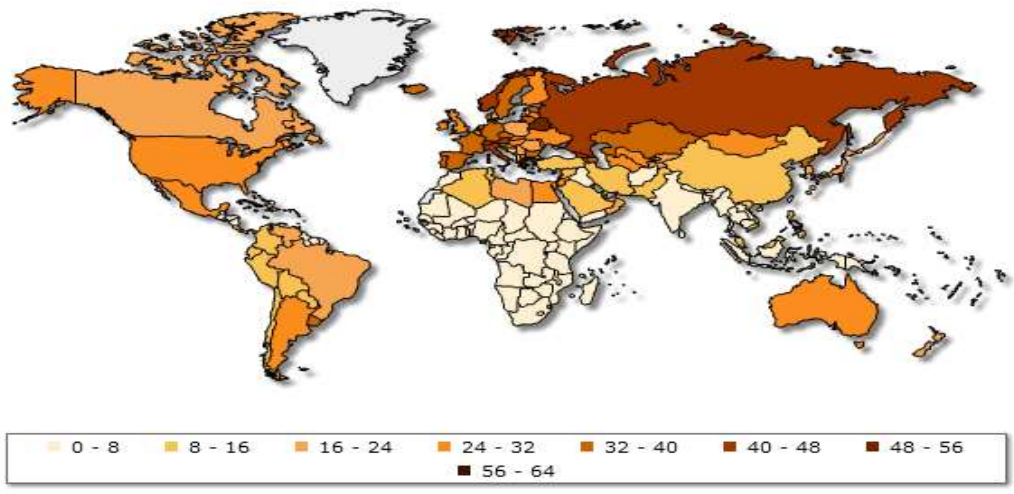

Figure 11.1 World map showing the healthcare facilities across countries

Instituting healthcare facilities at all levels of primary, secondary and tertiary levels with suitably qualified doctors is a 'logical' solution for reaching healthcare services to all citizens across the country. This, obviously is not practical as it is wrought with many imponderables, in terms of capital required and limitations in operational services including difficulty in retaining qualified medical practioners in the primary hospitals due to professional isolation of doctors in remote areas An innovative alternative to this limited and centralized Health Care Delivery "Infrastructure" is the distributed and Virtual Health Care delivery "Info-structure" called Telemedicine. This employs multiple technologies of Communication, IT and medical informatics for healthcare delivery.

Telemedicine is a powerful tool to address the problems of access, and meet healthcare delivery needs. Space technology provides a variety of tools to enable such services, helping the governments in fulfilling their obligations ,and the citizen in receiving good healthcare.

Figure 11.2 Enablers of the Modern healthcare delivery streams

The Space assets (satellites) are becoming more and more critical in enabling sustainable, long-term development and narrowing the digital divide,. Many citizens in remote, rural and sparsely populated areas, especially in developing countries, face a digital divide that creates inequities between those who do and those who do not have access to educational and medical resources. The ensuing lack of skills, results in enormous income disparities and poverty. The Space-based solution of cost-effective satellite enabled distance-learning programmes, functioning independent of ground based infrastructure, ensure connectivity across physical boundaries and thus helps bridge the gap between the "haves" and the "have-nots".

As per the Space Technology and Human Health report (WEF, 2014), the ability to innovate in healthcare technology and delivery is a constant human need, especially in the quest to provide equitable care to people across the globe. Space-based Telemedicine enabled by space satellites and technology of Geographic Information Systems (GIS), scientific research and other technology spin-offs enable new ways to improve human health on Earth (WEF, 2014).

Space technology of using Remote Sensing, Weather, Communication and Navigation satellite applications provide different services to different users and communities. A ll of them independently and collectively, are useful in providing medical and healthcare services to underprivileged sections and needy citizens, in geographically distant and difficult areas. Satellite technologies with ground based technologies like Geographic Information System (GIS), Global Positioning System (GPS) and IT along with medical sciences are useful in the lifecycle of healthcare and disease management encompassing prevention, mitigation, preparation, response and recovery.

- **Weather Monitoring and Remote Sensing for Health Management**

Health should not be considered in isolation. Progress in Health is directly proportional to progress in meteorology, agriculture, education, industry, science and technology etc. Earth observing /remote sensing satellites carry special devices like cameras and payloads. They orbit around the earth to gather information about the nature and condition of land, sea, atmosphere and the environment. Meteorological satellites carry instruments aboard, to monitor the weather and effects of pollution, auroras, sand and dust storms, snow cover, ice mapping, boundaries of ocean currents, energy flows, etc.

Weather satellites help in predicting floods and other natural disasters as well as identifying and monitoring these trouble spots. which leads to major health problems. GIS technology helps in integrating this data with the other data like human settlement zones and population density and maps them to identify vulnerable areas and populace for prevention or preparative measures.

More specifically, the Spaceborne Remote Sensing imagery is useful in detection, prevention and management of vector borne diseases,

Vector-borne diseases (VBD) account for more than 17% of all infectious diseases, causing more than 1 million deaths across the globe annually. More than 2.5 billion people in over 100 countries are at risk of contracting dengue alone. Malaria causes more than 400,000 deaths every year globally, most of them in children under 5 years of age.

Changes in agricultural practices due to variation in temperature and rainfall can also affect transmission of vector-borne diseases. Remote sensing imagery help in monitoring the agricultural extents, their patterns and their health/disease forms. Access to water and sanitation is important factor in disease control which can be monitored well using RS and GIS technologies. Climate information can be used in the monitoring and management of climate-sensitive diseases.

- **Satellite Communication for Healthcare Delivery**

Satellite communications (SATCom) is one of the fast growing key technologies in the world making the world a connected global village and helping many countries to build seamless information infrastructure. Communication satellites carry transponders aboard to receive, amplify and retransmit the signals and are generally orbiting around the earth in geostationary orbits about 36000 Km above the earth. Satellite based communication services are of

considerable use in healthcare services and can facilitate health-critical communications under most situations. This enables patients and remote doctors to connect to specialist doctors. This is particularly relevant in some geographically distant and inaccessible areas where other communication systems such as cellular phones and connectivity options may not be available or viable. SATCom helps bridge the digital divide in e-healthcare, as providing traditional terrestrial communications and other broadband infrastructure may not be feasible..

Very Small Aperture Terminal (VSAT), a small sized antenna based system mostly operating in C and Extended C bands utilizes transponders on communication satellites. They help connect remote health care providers to urban doctors helping reduce geographical isolation. ISRO has spearheaded SATCom based connectivity and systems for eHealth in India since 2001. One successful initiative to-date in Europe has been IGEA-SAT (Integrated General E-care Access for home care via SATellite) (IOT-now.com). Similarly many other countries use SATCom based connectivity for numerous requirements including healthcare delivery.

- **Satellite Navigation and Positioning for Healthcare Services**

Satellite Navigation (SatNav) service is an emerging satellite based system that uses satellites to calculate positions on the earth and providing driving directions. They have a major role to play in locating the medical facilities and delivery of healthcare services as well. Finding the location of hospitals, pharmacies, other medical facilities and geo-tagging them (marking on the GIS maps) for creating a healthcare and medical facilities layer in combination with Remote Sensing Imagery, is the initial use of such technology. Ambulances which provide a rapid response to life-threatening medical situations can be provided with satellite navigations systems. This ensures identifying precise location of the emergency spot and shifting the patient to the nearest medical facility identified. This satellite enabled directional service splays an important role in times of emergencies and critical care by going . to the right place at the right time

Navigation and positioning receivers have been miniaturized and are becoming cost effective making the technology affordable and accessible to everyone. In India, ISRO is committed to provide the satellite based navigation services to meet all the emerging demands

11.4 Space Technology & Applications - Indian Scenario

Among the various initiatives pursued by ISRO towards societal benefits, some important ones include tele-education, telemedicine and disaster management. The combination of Remote Sensing, Communication and Navigation satellites and their services are extensively used to provide these benefits.

ISRO is continuing to provide satellite based navigation services to meet emerging demands of users for positioning, navigation and timing through independent and indigenous satellite navigation systems. ISRO is establishing a regional satellite navigation system called Indian Regional Navigation Satellite System (IRNSS). It uses a communication payload on-board the spacecraft with two channels operating in L1 and L2 bands allocated for navigation purposes. Positioning services can be improved by a network of ground-based receivers. This

will be made available to users through geo-stationary satellites. The service can be put to use for healthcare services , locating medical facilities and for ambulance driving directions.

11.5 Telemedicine in India – ISRO's Initiatives

India is the 7th largest country in the world with an area of 3.2 million square kilometres and a population of 1250 million Majority of qualified doctors practice in urban centres, while majority of India's population live in rural areas. Initially SATCom technology was used, as Training & Development Communication Channels (TDCC), using one-way/two-way audio/video channels for rural education. This was called Jhabhua Development & Community Programme (JDCP), a Space based rural Development Initiative,. Subsequently ISRO took up Telemedicine as a special programme in 2001

Figure 11.3 Demonstration of Satcom Technology

ISRO's Telemedicine system consists of customized medical software integrated with computer hardware, along with medical diagnostic instruments connected to a commercial VSAT (Very Small Aperture Terminal) at each location. Generally, the medical record/history of the patient is sent to the Specialist Doctors, who will in-turn study the record. Through videoconference with the patient's end. a diagnosis is made and treatment suggested . The Telemedicine software is designed for specific/combination of—applications. Communication link is through the VSAT system. The VSAT system initially adopted is a Flexi DAMA/Flexi LAN system and the network is in the Mesh configuration. This is evolving and changing over the time with state of the art systems and technologies. The Central hub station for the Telemedicine network allocates bandwidth initially depending on the requirement and allows the link for continuous connectivity. The bandwidth used during video conferencing is typically 384 Kbps and during data transfer 64 to 128 Kbps and only during special cases 512 Kbps bandwidth is used.

The thrust of ISRO was to introduce SATCom based Telemedicine technology in the remotest part of the country through pilot projects. Following sufficient training and acquiring experience to run the facility, it was expected that the state governments would take over the running of the telemedicine facility. The focus of this endeavour has been to provide

technology and connectivity for Tele-consultation and treatment for by connecting Remote/Rural District Hospital to Super Specialty Hospitals. Continuing Medical Education (CME) programmes, including training of doctors and paramedics, Mobile Telemedicine for Rural Health camps especially for Ophthalmology and Community Health Programmes were the additional spinoffs.

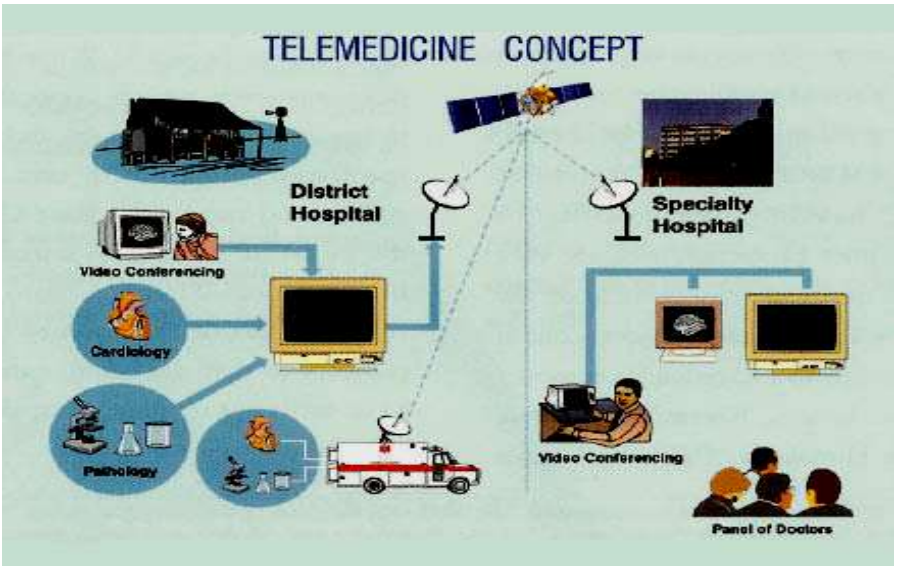

Figure 11.4 Pictorial representation of Satellite Enabled Teleconsult

The implementation began by establishing proof of concept of utilisation of technology through pilot projects in different parts of the country. The total solution viz., connectivity, hardware, software along with standard medical equipment was provided by ISRO to inculcate interest among the users. This resulted in awareness among the medical and patient/user community. Based on successful pilot projects, it was possible to take the system into an operational mode. State governments and many medical research and healthcare institutions came forward to expand their networks, by organising their own infrastructure, backed by free connectivity from ISRO. ONCONET under Tata Memorial Cancer Centre, Mumbai exclusively for Oncology consultation and Mobile Tele-ophthalmology units with satellite connectivity were provided for rural camps and health awareness programmes.

ISRO maintained the momentum , by organising different workshops and user seminars to create awareness and ensure improved utilisation and management. Different technologies were adopted from time to time, costs reduced by bringing-in cost effective solutions, to meet diverse socio-economic considerations. Applications include Cardiology, Radiology, Pathology, Ophthalmology and Oncology in realtime time as well as in the store and forward mode. The initial point-to-point system progressed to a point-to-multi-point and later to a multi-point to multi-point system Costs of large number of terminals were reduced and rural reach increased by deploying VSAT enabled Hospitals on Wheels

The growth of Indian Telemedicine was a result of

- Adopting new technologies and reducing complexity
- Reducing costs for economic viability
- Integrating multiple stakeholders - Government,Industry, Medical Community & Health Administration
- Supportive Initiatives by Insurance Agencies

These, coupled with collaborative efforts of several medical research organisations, Trust Hospitals, NGOs etc., has resulted in a substantial growth of the telemedicine network in India. ISRO's satellite based Telemedicine network itself grew from a mere 5 nodes in 2001 to about 400 nodes by 2010. There are several other networks run by other agencies. This was achieved through Satellite communication (SATCom) based Technology during the decade of 2000-2010 and then the expansion through alternate technologies and connectivity options.

Multiple states across India adopted ISRO supported Telemedicine services and also adapted them to their regional and local requirements. The operational models included funding the infrastructure and payments to doctors on par with traditional consultations.Presently, the ISRO Tele-medicine system encompasses cardiology, ophthalmology, diabetology, orthopaedics and the use of tele-clinics. Key considerations are access, rapid response, cost and time efficiency. Nearly 300,000 patients are treated annually using ISRO telemedicine services. (Kasturirangan and Madhura, 2015).

Considering importance of the healthcare system and taking into account international practices, the necessary guidelines and standards for the telemedicine system, has been drawn up under the aegis of the Ministry of Information Technology The standards refer to network /connectivity, interoperability of telemedicine systems and standards for security & process guidelines. . Healthcare data has also been standardized through use of DICOM, HL7 and ITU standards. Bedi & Remilla (2005) defined the concepts and elucidated on the standards required for hardware, software and clinical devices including security aspects for an overall growth and structured pattern. Moving beyond guidelines, initiatives are now in the offing to develop legal and regulatory framework for Telemedicine in India.

11.6 Journey of Telemedicine in India – Embracing Technologies

The Telemedicine system configured for the ISRO's Telemedicine project initially started with "point to point" system between the patient ends, which is a general hospital located in a district/town and expert doctors end which was a speciality hospital situated in a city. Subsequently due to the need for a Server/Browser based Telemedicine system a client/server configuration was evolved for multipoint connectivity. This was adopted for multipoint connectivity between a remote/rural hospital and a Super Speciality Hospital located in different towns and cities. Over time, this network grew to "point to multipoint" before expanding to "Multipoint to multipoint" mode.

ISRO's Telemedicine Network grew to about 425 nodes; 330 Hospitals and 55 Remote/Rural/District Hospital/Health Centres connected to about 40 Super Speciality Hospital located in major states like J&K, North Eastern Region, Chhattisgarh, Karnataka,

Kerala, Orissa, offshore Islands of Andaman & Lakshadweep. ISRO's telemedicine network included mobile Telemedicine Units/Vans.

Figure 11.5 Pictorial Representation of ISRO Telemedicine Network

11.7 ISRO's VSAT based Telemedicine Network

Efforts were made by various agencies to bring Telemedicine and e-Health into the mainstream of the healthcare system. The vision is that all district hospitals in the country be linked through Telemedicine. – The networks would be at a national level, connecting different states and various medical colleges, eventually resulting in a National Telemedicine Grid. There would be special emphasis on primary healthcare aspects, including women and child health care.

The new Indian government (after 2014 general elections), known for embracing innovation and highly adoptive to the new technology regimes, is thinking big in the form of Digital India where Telemedicine/Telehealth and Tele-education are essential components. With advances and increasing availability of alternate modes of communication and connectivity in most urban areas and metros ISRO has started to shift the focus to unconnected areas in truly rural and mountainous areas. In addition to traditional VSAT based SATCom connectivity, government and hospitals started embracing newer connectivity options like WLAN, Optical Fibres, State-wide WAN (SWAN) and internet technologies. These innovative approaches are leading to a multipurpose digital connectivity across the country, reaching the unreached for services and administration.

11.8 Future of Telemedicine – A Pertinent Application and Ray of Hope

With the ever-expanding internet, technology is now going from revolutionary to routine, from unimaginable to indispensable. Telemedicine is transforming wellness, disease management, medication management services and illness prevention while extending and

enhancing access to critical healthcare services. This can be optimized to carry medical information in various situations by utilizing readily available traditional wireless local area network (WLAN) and broadband wireless access (BWA) systems . The space faring nations are increasing the variety and quantity of satellites and satellite based solutions that can take these services to more remote and inaccessible areas which are not covered by the commercial Telecom operators' services. More and more countries are coming up with their own or hired satellite systems which should extend the benefits to wider regions across the globe.

Consumer healthcare technology is becoming more popular, as reduction in manufacturing cost of electronics products, makes healthcare products more affordable to the general public. Low cost IT solutions, financing programs, and interoperable systems are the focus of top healthcare IT solution providers. With rising adoption of healthcare IT, healthcare delivery models are expected to evolve from clinic centric to patient centric models, such as preventive healthcare, remote patient monitoring, telemedicine, and home healthcare.

As population ageing is becoming a significant concern in many countries, more care and monitoring will be needed. A significant increase in the application of wireless communications in elderly care, has been seen over the past few years, as related technologies become more mature. The cost of service becomes more affordable and portable devices become smaller and more user-friendly. As pervasive computing technology advances, more comprehensive and automated services will become available to the ageing population in the years to come (Stanford, 2002).

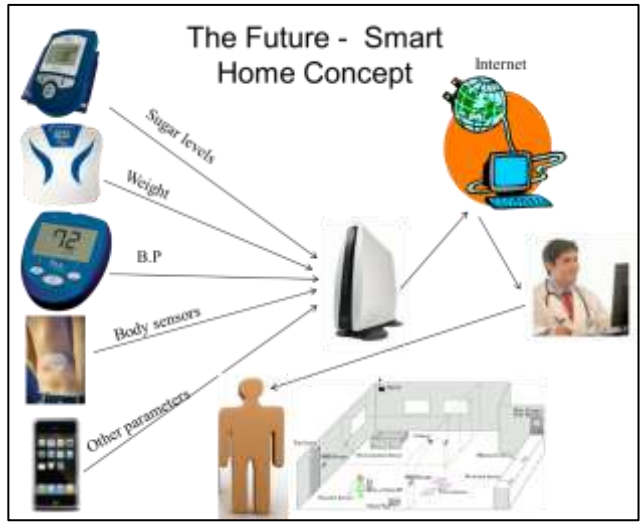

Figure 11.6 Pictorial Representation Future Smart Home Concept

With exponential increase in utilization of mobile phones and rural teledensity nearing 50 percent, healthcare based on mobile solutions has started to increase rapidly and is expected to grow further. Mobile technology is expected to greatly help in bridging the urban-rural health divide.

Figure 11.7 5 mHealth – The Doctor in Pocket

Telemedicine/eHealth has its own share of opportunities and challenges.

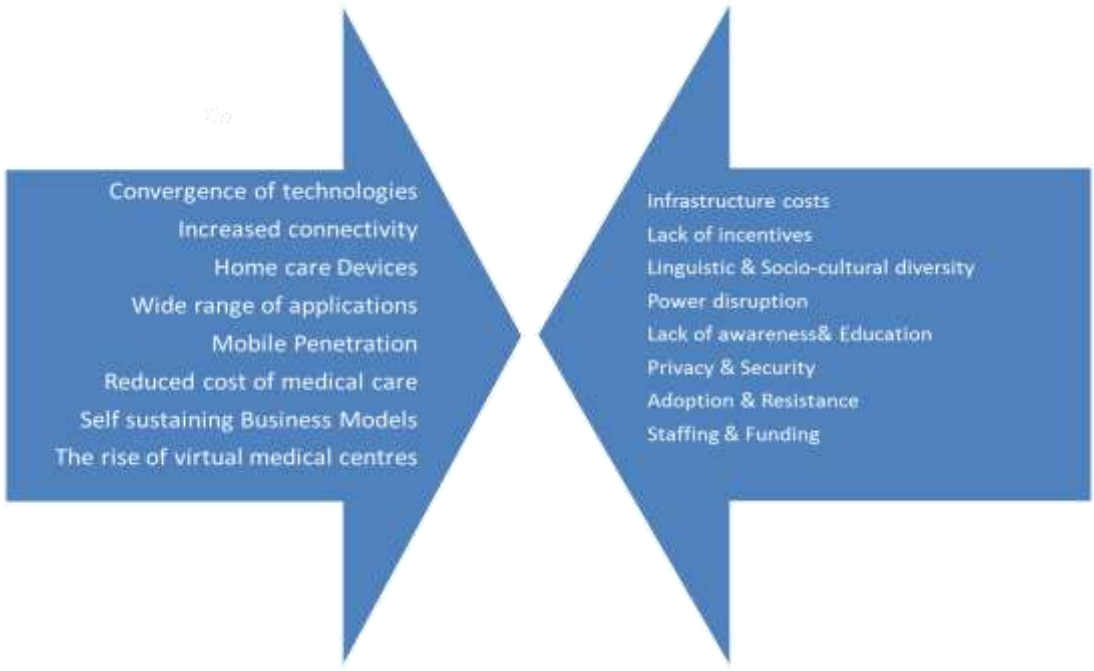

Figure 11.8 Opportunities and Challenges in Telemedicine

A perfect deployment and utilisation of technology driven facilities necessities , at the minimum:

- Leadership and political will by Governments to remove obstacles, encourage innovation and collaboration among stakeholders and ensure guidance to develop sustainable healthcare solutions,
- Improve outcomes or reduce costs for current outcomes
- Balance of Short-term and long-term perspectives (priorities, budgets and thrust)

- UPSCALE from pilot programs to national and international networks with interoperability
- Adopt and integrate Telemedicine in healthcare delivery systems as a standard of care
- Wisdom and willingness to balance Short-term and long-term perspectives (priorities and budgets)
- Concerted efforts towards economic solutions and costs reductions in development, deployment & sharing

The world healthcare IT industry is being impacted by government involvement and support for the adoption of ***Information Technology*** in healthcare worldwide. However, there is an imminent need for inviting and involving private entrepreneurs through Public-Private Partnerships (PPP). If the right decisions in the right directions are made at the right times, Telemedicine can progress in its journey from a Technology concept model to an Operational and revenue generation model for self-sustenance.

11.9 Conclusions

Space capabilities are a critical infrastructure not only for the owning states, but for the world. We are going to witness an exponential growth in space infrastructure leading to advanced technologies with associated applications. Technology is a tool to achieve an end. One needs to build a service delivery around it and deliver it with humanity. This is more so in the arena of healthcare delivery. Creating education and a Awareness among all the stakeholders starting from younger students is imperative. All of us as citizens and as responsible human beings should either contribute to the technology or use it for the benefit of humankind or at the least, spread the awareness of these benefits and ways to utilise them, to the needy, under-privileged segments in particular and to everyone in general.

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12 eHealth in 2030: A Peep into the Future

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12.1 Introduction

Looking into the future is a past time that has prevailed for centuries. There has always been a place for the soothsayer, the astrologer and the prophet. Futurology on the other hand is a pseudo science that assumes that the future is an extrapolation of the present and the past. This decade, is witnessing more changes than has ever occurred, since the dawn of civilisation. Terra firma will in 2030 have 12 billion inhabitants. The consumer (there will be no patients then) will talk to an intelligent system and following a user friendly menu make his / her own diagnosis. A virtual appointment will then be fixed automatically, if necessary, with the appropriate specialist. Management will, as far as possible, be domiciliary based. What about the planet itself? How will our world be in 2030 ? For a starter, the number of centenarians would be twenty times more. 15 to 20% of the population of several countries will be octogenarians.

Health itself will be considered a human right, an essential component of well-being, a global public good and an issue of social justice and equity. Health will be recognized as a product of all other systems, including the economy, environment, education and transport. Health will be accepted as a key factor for the economic prosperity of knowledge societies.

12.2 The changing Health Care Scenario

In 2000, health care was concentrated in large hospitals, to which patients were transported over long distances incurring considerable expenses. In 2016, mega hospitals are being replaced by smaller single speciality hospitals. Concept of remote and preventive health care is slowly being accepted. In 2030, Cybercare will enable bulk of healthcare to happen in the community and home. Super Hospitals will cater only to very specialized services. Today, hospitals and doctors "profit" when people are "sick". Day after tomorrow promoting wellness the eWay will be a viable business. Public Private Partnerships (PPP) will be the order of the day. Universal health coverage with mandatory insurance will be hopefully be a reality

ICT will deliver health care across a network –doctors will consult with patients via videoconferencing, through smart phones. These smart phones will have dozens of appropriate sensors and access to hundreds of health apps resulting in linking to tertiary medical specialists. The Cybercare model will be robust, efficient, and accessible to anyone, anytime, anywhere providing affordable quality health care. Complete personal health record of every citizen will be updated in real time and stored in the cloud. The individual, unlike today, will play a major role in managing his own health with, if required, he help of a nurse practitioner , physician assistant or family member in their home or local clinic.

Smart robots with AI (Artificial Intelligence) will help the patient conduct or interpret lab tests and other tasks at home. The Internet, mobile computing and inexpensive sensors will offer an opportunity to democratize health care and make the overall system resilient.

People will die from diabesity rather than starvation. A borderless world will necessitate international tele licensures for clinicians. In developing countries, people over 65 will triple from 249 million to 690 million. Many consumer services may deliver goods and services, within hours of online ordering, and perhaps even through a drone. Remote consultations may evolve into remote interventions, saving patients the cost and complexity of transportation. *When health care is more accessible it will be more utilized* preventing ailments from progressing. Capsule robots that can be swallowed, with cameras to observe and diagnose, tools to take biopsies, sensors to check tissue, and needles to administer drugs may not be in the realm of science fiction. A hospital's central role will diminish. Fewer brick and mortar hospitals will be built.

Even the house call will return, but it will now be a eVisit. The author as early as 2010, had facilitated electronic house visits in Chennai .Today's regulatory and legal barriers to escalating a distributed, networked healthcare model are likely to have been successfully addressed. Due to the falling cost of sequencing and proliferation of direct-to- consumer tests, such as 23andme.com and ancestry.com, there is likely to be a greater shift towards genomic-based personalised medicine. 4P medicine will be the standard of care (Predictive, Personalised, Participatory and Preventive) , Responsibility of care will shift from the physician to the patient, from treatment-based care to preventive care, with a subsequent dramatic reduction in the overall cost of health care. New innovative technology will by today's standards be disruptive. Incremental changes will be replaced by exponential transformation revolutionising health care as we know it today.

The concepts of health and health care are moving towards the notion of " Stay Healthy' rather than today's diagnostic and curative medicine. Contemporary public health challenges like increasing costs, worsening outcomes, 'diabesity' epidemics, and physician shortages are being addressed by deploying ICT. This is resulting in big health data which in turn requires a qualitative shift in mindset. A 2011 Pew Internet study found that 80% of Internet users look for health information online. Big health data applications are important in the realization of preventive medicine at both macro and micro level. At the macro level, they provide the capability to track health-related issues at the vast scale of worldwide populations in effective low-cost ways

Networked diagnostic devices for remote in-home monitoring will be commonplace. Medical and patient data will be fully digitized. Technology enabled care will increase provider productivity, deliver cost savings, reduce avoidable service use, improve health outcomes and deliver Connected health. Connected health is the concept of providing patient centric care by maximizing healthcare resources. It provides increased, flexible opportunities for patients to engage with clinicians and better self-manage their care. Connected health puts the patient at the centre of the healthcare system gathering, linking and interpreting information from many different sources to enable informed, patient-centred care decisions. It has the potential to transform healthcare delivery and address many care coordination challenges faced worldwide.

12.3 mHealth and Wearable Technology

mHealth refers to the use of mobile devices to deliver healthcare related services.Mobile phones and tablets will be used for real-time monitoring of patients and direct patient care. The number of healthcare apps in iOS and Android has already more than doubled in 2.5 years to 100,000. By 2030 this number will grow exponentially not incrementally. Clinicians will use remote monitoring apps to track major patient health events including exercise, nutrition and sleep habits. This will result in increased patient compliance improving patient care and collaboration. Sending SMS will be a routine in any healthcare delivery function. . In the mobile health space alone, India has witnessed significant activity with the launch of several different services. Though the majority of initiatives are now focused on spreading prevention and awareness messages, it is likely that in the next 15 years using Wifi enabled smart devices the continuum of care will be effectively implemented. The Indian Medical technology industry is expected to touch 910 billion INR in 2020 .

Recreational voice-based chatting with Siri, Cortana or Google assistant will soon lead to continuous availability of elaborate personal virtual coaches Preventive medicine is inherently democratized, with the individual as the center of action-taking, with free or inexpensive self-tracking and monitoring solutions and online personal health records on one's smart phone. For the patient provider to adequately utilize this information they will need to track their day-to-day activities using wearable technology. By 2030, a smartphone could be enabled to do a genomic analysis. A family physician wearing smart glasses, communicates to a remote specialist who sees exactly what the family physician sees, on *his* giant touch screen. He draws instructions on the smart glasses' display to guide the remote doctor. The Smart glass used by the family physician requires very little space and works on battery power. Teleconsultants will no longer have to go to telemedicine departments as is being done now.

12.4 Smart Health

In 2030 there will be a totally new perspective on the governance of health and well-being**.** Smart cities and smart villages will have smart health as an integral component. That healthcare is absolutely essential even for sustenance is well known. Water management, energy management, building automation, transportation –every single item in the formation of a smart city presupposes healthy individuals in the 'smart community'. Attention to 'smart healthcare' (SHC) in 2030 is therefore not a luxury but an absolute necessity. Contrary to public perception, providing 'smart healthcare' is eminently feasible, cost effective and just needs a little tweaking of software and hardware used to provide other 'smart facilities'. The challenges in implementing SHC are more with individuals than with the technology. Today, receiving remote health care is not like buying a pizza online or a commodity on Flipkart. Champions and evangelists from the Health Care Community of today, who have a passion and believe in SHC would have ensured that the necessary behavioural modification has been done. Health is an inherent and major component, which must always be taken into account while planning a smart city. Whether it be pollution, the metro or even water or transportation management, inputs of a clinician who is familiar with technology and its implications and most importantly the behavioural responsetouse/ imposition of technology, needs to be considered . In the past, health has always been an afterthought, retrofitting being the order of the day – In 2030 this will not be the case.

SHC presupposes: a) DIY (Do it yourself) b) POCD (Point of Care Diagnostics) c) Promoting wellness proactively d) Staying Smart the eWay. While behavioural modification at all levels of the healthcare ecosystem is critical in deploying SHC, it is WiiiFM (**W**hat *i*s **i**n *i*t **F**or **M**e) that needs to be primarily addressed. Some examples of SHC are provided below :

a. Promoting health literacy the eWay providing authenticated, validated customised health informaton to a pre defined population through smart phones etc. If public WiFi is available this could be exploited
b. Telemedicine enabled *pre-hospital management* in smart ambulances for emergencies, trauma etc
c. *Remote health monitoring at home* that reduces hospital bed occupancy by converting a home into a hi care ward using technology. Today's glucometers can be supplemented with similar tests for liver function , kidney function, cardiac function etc. This can be done with just a few drops of blood obtained with a pin prick. Even a paramedic is not required. 'Smart' diagnostics will result in non-invasive sensors studying blood biochemistry trans dermally using surrogate biomarkers . Eventually even urinalysis will be able to throw light on brain functions .
d. Large residential complexes can have in-house SHC for its residents.
e. Large offices can have in-house SHC for employees Family physicians, specialists, super specialists can conduct virtual OPs at offices, malls and residences.
f. Most importantly24/7availabilityof PHR (personal health records) on the cloud, will avoid duplication of investigations. Immediate access to entire past and present medical history to authorised personnel will produce high quality health care delivery
g. Scientific, statistical evaluation of health care outcomes, incidence prevalence, follow up etc. will be feasible

12.5 Challenges in Implementing Machine-to-Machine (m2m) and Internet of Things (IoT)

Care requirements are variable in different places, at different times and for different people. Hence the product has to be packaged and customised to suit each customer. In most m2m implementations and designing, sufficient emphasis is not given to the specific needs. A HCP (Healthcare Provider) should be involved at every stage not just an m2m expert. Reliability and accuracy is critical as the user's health and life are directly involved. Any m2m product must be compared with existing gold standards. Prospective double blinded, randomised, statistically valid clinical trials are necessary with patient feedback, before accepting an m2m tool in the healthcare delivery system. Most m2m products in healthcare are driven by mega MNCs with an eye on RoI – whether they are useful or necessary is secondary! Interoperability and the need for standards is as essential as with any other 'smart' application, but we need not get paranoid about this.

Internet of Things (IoT) will inter connect uniquely identifiable embedded computing like devices within the existing Internet infrastructure. IoT will offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) . It will cover a variety of protocols, domains, and applications. The interconnection of these smart embedded devices will usher in automation in nearly all areas of health care. IoT embraces the fact that all products, devices, facilities, systems, equipment, delivered goods,

processes, workflows, and people will coexist in a connected world, interacting and being inter-dependent.

12.6 Conclusion

The unreasonable man persists in trying to adapt the world to himself. Therefore all progress, depends on the unreasonable Man, said George Bernard Shaw. The pioneers in the field of telehealth in India are most unreasonable individuals, who wanted to get things done yesterday and that is why we have today ! Health in 2030 will essentially be the result of what is being done today. . Nothing can stop an idea whose time has come, said Walter Hugo. We are today in a stage of transition. All transitions offer great opportunities. It takes decades of behavioural modification to accept, what is in contravention to centuries' practice of healthcare delivery. Hopefully in 2030, society would have gone beyond today's stage of transition and taken the best from yesteryears. After all good and evil are two sides of the same coin. Humankind is now witnessing a growth in HCIT ,unprecedented in any discipline, in the annals of history. A new species *Homo Digiticus* is evolving. Interestingly this mutation is more in emerging economies. By 2020, 50% of inhabitants in the west, will wear one or more bio-sensors. 50 billion devices will be connected to the internet 20% of which will be mobile. Machines will be interacting directly (M to M – or the internet of things) with the World Wide Web rather than the present human to machine interaction .With almost one billion humans, using social networks, Dr Facebook could very well be the new healthcare provider making distance meaningless and Geography History ! Just to put things in the proper perspective in 2011 alone 29 million lab results were viewed online by patients of the Kaiser Permanente alone, the largest health care network in the USA. 12 million e-visits were made between patients

Physicians will be tempted to treat the scan, the DNA data and the biosensor output, not the patient *per se . After all it takes more time to listen to, examine, understand and interact with a patient*. Remote monitoring and diminished face-to face visits could contribute to a significant loss of the proverbial healing touch and TLC (tender, loving care) a hallmark of the 20th century clinician. At a time when any human being can be essentially reduced to six characters (even if there are quadrillions of 0s, 1s, A's, Cs, Ts, and Gs) the dehumanizing concerns must be understood

You either ride the steam roller of new technology or become part of the road . The only thing that is *constant* in the universe is change. Many of us are afraid of the future and cling desperately to the present not realising that we are already the past. The famous science fiction writer Arthur Clarke once said, *" Advanced Technology will eventually be indistinguishable from magic*" To face this magic, what we require in the coming decades, is a mature head on young shoulders - not to get carried away by gadgets. A technology in search of an application is doomed for failure. We should never forget that we have the unique privilege of combining tender loving care with tomorrow's technology. Science without compassion is blind, compassion without science is lame. In our anxiety to reach Mars let us never forget that technology is a means to an end and not an end in itself.

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The National Design and Research Forum (NDRF) of the Institution of Engineers (India), providing a National platform for Engineers, Scientists and Technocrats engaged in Research and Design activities was established at Bangalore in 1969. NDRF has emerged as a forum for exploring and disseminating new and emerging design and research concepts. NDRF 0 dedicated to provide an international forum for the discussion of design and research in the context of current issues of the nation. NDRF is committed for design and research professionals from every discipline in engineering, science and technology because design on any-scale is by its nature multidisciplinary. Since 1985 NDRF is coordinating, monitoring and progressing in the following areas:

Micro and Nano Air Vehicles | 3D printing, Protolab, Rapid Prototyping and Tooling
Biomimetic, Bio and Chemical Sensors | Interfacing of Biology and Engineering
Bird Strike Research, Research and Design Publications | Design Awards

During the National Conference on Telemedicine held in Lucknow in April 2001 the participants resolved to form a scientific society dedicated to Telemedicine at national level and carry out annual scientific event pending a formal registration, thus the Telemedicine Society of India was born and all the participants signed a resolution to this effect and are made the founding members

The society got formally registered in 2006 at Lucknow having its registered office at Telemedicine Center, Sanjay Gandhi Postgraduate Institute of Medical Sciences. Considerable progress has been made over last few years.

The Telemedicine Society of India, is now a reality. IsfTeH, the International Society for Telemedicine and e-Health, has now recognized TSI as the official national society representing Telemedicine activities in India.

The society had its First, Second, Third, Fourth, Fifth, Sixth , Seventh and Eighth Annual Conferences held at Lucknow(2002), New Delhi (2006), Chennai (2007), Chandigarh (2008), Pune(2009), Bhubaneswar(2010), Mumbai (2011) , Coimbatore(2012), Jaipur(2013), Bhopal (2014) & Kolkata (2015) respectively.

The Institution of Engineers (India) or IEI is the largest multidisciplinary professional body that encompasses 15 engineering disciplines and gives engineers a global platform from which to share professional interest. IEI has a membership strength of over 0.7 million. Established in 1920, IEI has served the engineering fraternity for over nine decades. In this period of time, it has been inextricably linked with the history of modern-day engineering

The Institution was formally registered in Madras under Indian Companies Act of 1913. The Institution was granted the Royal Charter in 1935, which emphasized on promotion and advancement of Science, Practice and Business of Engineering in all its branches in India.

The Institution of Engineers (India)

- Ensure the highest standards of quality in every aspect of professional development and practice.
- Focus and capitalize on areas of core competence as well as areas where significant competitive advantage exists

In addition to representing India in the Engineers Mobility Forum, the institution has been prominent in World Mining Congress (WMC), the World Federation of Engineering Organizations (WFEO), the Commonwealth Engineers' Council (CEC), the Fédération Internationale du Béton (fib), and the Federation of Engineering Institutions of South and Central Asia (FEISCA). It has no worldwide bilateral agreements with other professional societies.