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On Redefining Telemedicine Paradigm: An Innovative Integrated Model for Efficient Implementation of Healthcare Delivery in Developing Countries

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1. Introduction

There is varied accounts of the history of telemedicine in the published literature as well as in popular discourse. A careful review of these accounts reveals a common characteristic, despite significant variability between them. None of the reports has seriously considered the full story of telemedicine, including its continuity in medical practice in one form or another from ancient times to the present, the enduring necessity of connectivity in the delivery of medical care, the various transformations of telemedicine over the ages, or most importantly the contexts that sustained interest in this modality of practice. These accounts do not pay adequate attention to the rich context that prompted the early experimentation in the use of telecommunication technology in the delivery of healthcare and that continues to guide its development and transformation into the future. Delving into the detailed history of telecommunications as well as accounts and analysis of various national and regional initiatives aimed only at addressing the issues of healthcare access, quality, and cost . Nonetheless, the unintended detour gives a valuable insight and a genuine appreciation of the complexity and difficulty of designing optimal health systems that serve all segments of the population and that assure equity of access to standardized care at affordable prices. Indeed, gaining a better understanding of the broader context for the initiation, development, and persistence and the unique role a telemedicine can play in redressing intransigent problems in healthcare delivery as we go forward into an increasingly complex healthcare environment.

Tracing the history of long-distance communication from its humble origins in semaphore, and much later the telegraph, and radio to advanced digital communication and computer processing systems and even the recent trends in the transformation of telemedicine from simple ''connectivity'' tools to ''versatility' tools in the mainstream of medical care, such as the use of telemedicine for clinical decision support, prescription ordering, disease management, patient empowerment, and disaster preparedness / response. These new application areas appropriate in various clinical settings and environments. However, they are not limited to connecting distant participants. Hence, it raises a question whether the term ''telemedicine'' still applies to these applications under our broader discussion of the

nomenclature in this field. This chapter makes a special effort to place telemedicine development in its proper context, not simply as a technological innovation but as an effective solution to persistent problems in healthcare delivery including inequitable access to care in the population at large, uneven distribution of quality, and unabated cost inflation. Indeed, the persistence of these problems has provided the strongest rationale for the development and growth of telemedicine. The search for telemedicine's roots revealed the enduring need for connectivity in medical care in ancient times and the failure of repeated initiatives and national programs to address problems of inequity of access to healthcare in the population, discrepancies in quality of care between areas and regions, and unabated cost inflation in modern times. There is a great difference between the developing and the developed world on issues of health and healthcare services. The emphasis of the developing world is on basic survival (such as providing better access to healthcare and increasing the quality of health) whilst in the developed world, the emphasis is on reducing public funding for healthcare. Indeed, the rapid increases in healthcare costs and finding ways to control them have become the most important health policy issues for the developed world in the past few decades (Industry Canada, 2006).

The case for telemedicine rests on its promise to address some aspects of all of these problems in one form or another. Whereas the importance of these problems is universally acknowledged, for many observers, the efficacy of telemedicine remains a promise. For others, it has already been demonstrated at a reasonable level of confidence. In response to this discrepancy in perspective regarding the true merit of telemedicine, we have tried to highlight the scientific evidence available to date, in order to achieve as much closure on the question as possible. Also, since evaluative research will continue to occupy centre stage, we have attempted to identify the methodological requirements for this research as we pursue the search for more conclusive evidence regarding the true merit of telemedicine.

2. Health scenario in India

India is a second most highly populated ancient country with rich history, culture, and traditions coupled with geography and environment that encompasses the entire spectrum of conditions and bio-diversity. A large segment of population resides in rural and suburban areas, which lack adequate health infrastruction. To ensure that all sections of the society is able to fully participate in its development and progression has been, continues to be, and will do so in future, a challenge to one and all. With its more than a billion population, there exists a finite limit of elasticity in providing healthcare in terms of infrastructure, facility, manpower and funds. Wide disparities continue to persist between the various income groups, communities, states and even the districts within a state. With a predominantly rural population that are distributed over wide geographical locations, apart from the densely populated urban areas, providing even the basic and minimally acceptable healthcare has been and continues to be the priority of Indian health administrators. Further this is compounded by the following factors like:

- Low paying capacity of the rural population
- Lack of investment in health care in rural areas
- Inadequate medical facilities in rural & inaccessible areas
- Problem of retaining doctors in rural areas where they are required to serve & propagate widespread health awareness.
- Specialist doctors cannot be retained at rural areas as they will be professionally isolated and become obsolete and even monetary incentives also cannot prevent it.

2.1 The facts on India's health care situation are as follows

- 620 million live in rural India (National Council for Applied Economic Research (NCAER))
- Bed-Population ratio 1.85 per thousand (2005) Vs. ideal of 1:500 Central bereau of health intelligence CBHI)
- Doctor-patient ratio in the country is one doctor for nearly 2,000 persons (in the US it is 1:400),
- 2 million beds are required as against 0.7 million available.
- 700 hospitals of 250 beds each are required every year.
- only 9% of 1 billion people are covered health schemes.
- only 0.9% of GDP for health (WHO recommends 5%)
- 5% of annual family income spent towards curative health care.

The distribution of specialists in India is indeed lopsided. There are more neurologists and neurosurgeons in Chennai, than in all the states of North eastern India put together. Similarly tertiary care hospitals are also concentrated in pockets with large segments of the population having no access.

India is short of 600,000 doctors, 1 million nurses, and 200,000 dental surgeons to achieve 1:10,000 doctor-patient ratio. A recent survey by the Indian Medical society has found 75% of qualified consulting doctors practice in urban centers and 23% in semi urban areas and only 2% from rural areas whereas majority of the patients come from rural areas. . Contagious, infectious and waterborne diseases such as diarrhoea, amoebiasis, typhoid, infectious hepatitis, worm infestations, measles, malaria, tuberculosis, whooping cough, respiratory infections, pneumonia and reproductive tract infections dominate the morbidity pattern, especially in rural areas. However, non-communicable diseases such as cancer, blindness, mental illness, hypertension, diabetes, HIV / AIDS, etc. are also on the rise. Health being a State of subject in every human life, the data in regard to **Doctor-patient ratio** (D:P)in various State Government Hospitals is not maintained centrally. The doctor-patient ratio, varies from case to case depending upon various factors like the type of disease, nature of specialization, type of patient-care required i.e. indoor/outdoor. According to the Medical Council of india, the present allopathic doctor-population ratio at present works out to 1:1722.

The health of a nation is the product of many factors and forces that combine and interact. Economic growth, per capita income, literacy, education, age at marriage, birth rates, information on health care and nutrition, access to safe drinking water, public and private health care infrastructure, access to preventive health and medical care and the health insurance are among the contributing factors. Given that many conditions are preventable, every health care interaction should include prevention support. When patients are systematically provided with information and skills to reduce health risks, substance use, stop using tobacco products, practice safe sex, eat healthy foods, and engage in physical activity can dramatically reduce the long-term burden and health care demands of chronic conditions. To promote prevention in health care: awareness rising, change in thinking, stimulate the commitment of patients and families, health care teams, communities and policy-makers is crucial. A collaborative management approach at the primary health care level with patients, their families and other health care actors is a must to effectively prevent many major contributors to the burden of disease. Given that many conditions are preventable, every health care interaction should be recorded.

The advances in medical science and biomedical engineering on one side and Information and Communication Technology (ICT) on the other are offering wide opportunities for improved health care. Despite making great strides in overall development and uplifting of largely rural-based, thickly populated urban areas and essentially economically challenged sections of the society, providing proper and desirable levels of health care to them still remains an unfulfilled dream.

Telemedicine is supposed to contribute quality health care to those in need irrespective of socio economic ,density, geographical disparities and should be available for the benefit of all people located in dense urban, rural, remote and inaccessible places, and to further enhance its end-to-end capability. An efficient telemedicine network would mean that a large amounts of data (like medical records) is generated and maintained. These databases would be accessible on a national/ international telemedicine grid. Software and hardware is needed to manage all this, and organizations to take care of the operations.

Most decision-makers, managers, health care professionals and citizens lack basic information on telemedicine services and potential. This has resulted in misconceptions, resistance to telemedicine and relative lack of progress in project initiation. Telemedicine is still not recognized as a technical programme within the ministries of health and is not a unit at the ministries of telecommunications. The idea of being treated from one's home is very comforting and is proving to be cost-effective. Driven by the aging population, the increased medical requirements in remote locations, and the recent advancements in technology, the world market for telemedicine is forecast to reach $18 billion by 2015 (Source: Global Industry Analysts Inc.). Hence, telemedicine will soon play a very important role inhuman life. This has resulted in dealing with telemedicine projects as pilot or demonstration projects despite the fact that they are fully functional and operational in most cases. Developing Countries does not have the necessary legal and administrative framework to incorporate telemedicine service in the national health care systems. There is a need to develop plans or to create frameworks to introduce telemedicine services at the national level. Full understanding and commitment by top management to telemedicine should be secured and seen as essential for the success of telemedicine projects. Introduction of telemedicine as part of the national health care system requires thorough study and consideration at all levels. There is an acute need for telemedicine services with special emphasis on tele-consultation, tele-education and tele-radiology. Continuous medical education has become an integral element of patient care in an ever-expanding field of medicine. Tele-education can help as many health care professionals in remote areas deprived from any means of continuing education, the heterogeneous background of health care professionals with different medical and health backgrounds, the lack of organized health education.

Various organizations & researchers defined Telemedicine as :

Definition 1

The delivery of health care services, where distance is a critical factor, by health care professionals using info & Communication Technologies for exchange of valid information for diagnosis, treatment & prevention of diseases & injuries, research & evaluation and for the continuing of health care providers all in the interest of advancing the health and their communities.

---World Health Organisation

Definition 2

TM N/ W is to provide quality, cost effective patient care to underserved rural communities &Providing access to specialty care with in rural community needs of patient is met by decreasing travel time, cost & lost wages and impact of time & distance on morbidity.

--- University of Tennesse Med center

Definition 3

Rapid access to shared and remote medical expertise by means of Telecommunications & Informatio Technology. No matter where the patient or relevant information is located**.**

--European Commissions Health care Telematics program

Definition 4

The use of electronic medical info. & Comm. To provide and support health care when distance separates the participants

---www.Hospitalmgt.net

Definition 5

T.M is the use of medical info. Exchange from onsite to another via electronic Communication to improve patients health or status of health care provider.

---American Telemedicine Association

Def6

T.M. is the investigation , monitoring and management of patients and education of patients & staff using systems which allow ready access to expert advice & patients info. No matter where the patient or relevant info is located.

----European Health Telematics research programme

Other Definitions

T.M services provide means to improve accessibility to high quality health care in case of shortage of appropriate health professionals or the necessary medical expertise or skills at the site of the patient.

T.M thus covers a broad spectrum of services such as tele-consultation, second opinion, homecare and training and builds on technologies such as video-conferencing supported by the exchange of medical images and medical records as well as remote Monitoring. Communication infrastructures include ordinary telephone landlines, internet connections of various speeds and in many instances also satellite links to enable health care in remote and isolated areas.

T.M is a generic term covering the application of a variety of proven electronic and communication techniques in providing healthcare. Telemedicine offers the potential to alleviate the severe shortage of medical specialists in developing countries.

However the traditional approach to telemedicine relies on real-time video interaction between the specialist and the referring physician or patient). Digital imaging and the availability of ISDN lines have extended the reach of this technology in developed countries, but it remains impractical and uneconomic in remote and resource poor areas. However, medical diagnosis and management can often be achieved with the use of textual descriptions and still images. This "store-and-forward" approach to telemedicine simulates

the working patterns of radiologists, pathologists, and those of certain clinical specialties such as dermatology, infectious diseases.

After critical investigations in all the above definitions stated revealed that the root cause or locus for origination of TM is POOR DOCTOR TO PATIENT RATIO (D:P). In all the definitions stated it is true only in geographically isolated or less densely populated developed countries . While in high densely populated developing countries like india , china and many other countries all over the world the situation is different where there is an acute shortage of physicians and medical specialties. Due to high cost and poor living conditions, people below the poverty line are not ready to afford their earnings and time towards health care.

In view of various definitions stated without looking into the fact of D:P, it is now essential to **Redefine** TM in such a way so as to include the phrase **To improve Doctor to Patient Ratio**.

While many visionaries believe that increasing Doctors is solely the solution to the above problem of poor D: P. Investigations & surveys in many health care modalities have revealed that early detection of any abnormality can reduce the risk of health. Preventive Health care reduces the number of patients and hence the need for more doctors, thereby increasing virtually D: P.

2.2 Preventive healthcare

Preventive healthcare involves measures taken to identify and minimize risk factors for disease, improve the course of an existing disease and screening for early detection of diseases in people who do not yet have any signs or symptoms. Early recognition and prevention of disease is an important part of healthcare because it detects disease at the initial and curable stages thereby preventing complications and co-morbidities. It is also cheaper and effective than treating a full-blown disease at a later stage. It also involves health promotion, which is aimed at modifying the individual's social circumstance and lifestyles so that their health is improved (or maintained) and disease is prevented. Another aspect of Preventive Healthcare is the early identification of high-risk individuals prone to major life-threatening illnesses like heart disease and cancers. This helps in taking timely, precautionary lifestyle modification measures or treatment. The ultimate goal of screening is to help people live longer, healthier lives.

2.3 Why is preventive healthcare so crucial?

Some diseases like cancers cannot be cured if they are diagnosed at an advanced state while some disorders like heart disease may result in sudden death without any previous warning signs. Prevention, in such cases, is not only better than cure but is often the only option for a healthy life. Modern lifestyles don't leave people with quality time for healthy routines. It then becomes necessary that periodic health checkups be done for early detection of risk factors and diseases. Diabetes, Obesity, Hypertension, Stress, High Cholesterol, Heart Diseases. Most of the diseases are "silent", We often do not have any early symptoms. Hence regular screening tests are the only way for early detection. All these diseases are quite debilitating. They seriously impair normal life and if left untreated, lead to complications and may even cause death. Fortunately, these diseases can be easily prevented and even fully cured if detected early. Some of these diseases can be 'managed' so that one can lead a near normal life. All that one need to do is to make slight modifications

in your lifestyle, eat regularly and responsibly, exercise, avoid stress, and sleep well. Regular health check – ups coupled with these lifestyle changes, can go a long way in the prevention, early detection and cure of these diseases.

2.4 Integrating prevention into health care

Due to public health successes, people are ageing and are increasingly living with one or more chronic conditions for decades. This places new, long-term demands on health care systems. Not only are chronic conditions projected to be the leading cause of disability throughout the world by the year 2020; if not successfully prevented and managed, they will become the most expensive problems faced by our health care systems. People with diabetes, for example, generate health care costs that are two to three times those without the condition, and in Latin America the costs of lost production due to diabetes are estimated to be five times the direct health care costs. In this respect, chronic conditions pose a threat to all countries from a health and economic standpoint.

Many costly and disabling conditions - cardiovascular diseases, cancer, diabetes and chronic respiratory diseases - are linked by common preventable risk factors. Tobacco use, prolonged, unhealthy nutrition, physical inactivity, and excessive alcohol use are major causes and risk factors for these conditions. Trends in tobacco use will increase in the foreseeable future especially in developing countries. The ongoing nutritional transition expressed through increased consumption of high fat and high salt food products will contribute to the rising burden of heart disease, stroke, obesity and diabetes. Changes in activity patterns as a consequence of the rise of motorized transport, sedentary leisure time activities such as television watching will lead to physical inactivity in all but the poorest populations. Many diseases can be prevented, yet health care systems do not make the best use of their available resources to support this process. All too often, health care workers fail to seize patient interactions as opportunities to inform patients about health promotion and disease prevention strategies.

2.5 Current systems of health care

Many diseases can be prevented, yet health care systems do not make the best use of their available resources to support this process. All too often, health care workers fail to seize patient interactions as opportunities to inform patients about health promotion and disease prevention strategies.

Most current health care systems are based on responding to acute problems, urgent needs of patients, and pressing concerns. Testing, diagnosing, relieving symptoms, and expecting a cure are hallmarks of contemporary health care. While these functions are appropriate for acute and episodic health problems, a notable disparity occurs when applying this model of care to the prevention and management of chronic conditions. Preventive health care is inherently different from health care for acute problems, and in this regard, current health care systems worldwide fall remarkably short.

2.6 How can health systems respond to this challenge?

Given that many conditions are preventable, every health care interaction should include prevention support. When patients are systematically provided with information and skills to reduce health risks, they are more likely to reduce substance use, to stop using tobacco products, to practice safe sex, to eat healthy foods, and to engage in physical activity. These

risk reducing behaviors can dramatically reduce the long-term burden and health care demands of chronic conditions. To promote prevention in health care, awareness rising is crucial to promote a change in thinking and to stimulate the commitment and action of patients and families, health care teams, communities, and policy-makers.

A collaborative medical data management approach at the primary health care level with patients, their families and other health care actors is a must to effectively prevent many major contributors to the burden of disease.

Many health care institutions have been investing in computerized systems for years, but only to automate the administrative or back-office work within the institution. New information systems are being designed to enable health information exchange across systems and institutions. Evidence suggests the use of secure, standards-based Health Information Technology and the timely, electronic exchange of health information could improve patient care, increase efficiency, and result in:

- Higher quality care through adherence to treatment protocols and guidelines;
- Reduction in adverse drug events and detection of pending patient error;
- Fewer duplicative treatments and tests;
- Administrative efficiencies through decreased paperwork;
- Improved population health and coordination of clinical care as a result of timely and appropriate access to individual and community health information;
- Early detection of infectious disease outbreaks around the country;
- Disease management tracking; and More complete data sources for use in research and policy.
- Comprehensive data on patients' conditions, treatments and outcomes.

Therefore Electronic Medical Records(EMR) A model emerged to be a dominant frame work for TM evaluation & research. Rapid technological development in IT which has lead to the emergence of new ways of managing information. Specifically for health care, the need for portability & instant communication has transformed use of EMR to create a more complete source of health care data management.

The Electronic Health Record (EHR) is a longitudinal electronic record of patient health information, shown as Appendix, generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, observations, laboratory tests, diagnostic, treatments, therapies, drugs administered medications, vital signs, past medical history, immunizations and radiology reports etc. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter, as well as supporting other care-related activities directly or indirectly via interface—including evidence-based decision support, quality management, and outcomes reporting.

EHR systems support physicians and other healthcare professionals in the delivery of care management services. Although published literature on the use of EHR systems in care management in solo and small group practices is very limited, there is a growing recognition of the role of EHR systems to support individual and population-based care management in medical practices. Independent of practice size, EHR systems support physicians and care teams in multiple care management areas, including patient self-management, individual and population management, delivery system design, and clinical decision support system.

2.7 Integrated health care

The Electronic Health Record (EHR) has been a key research field in medical informatics for many years. It refers to the complete set of information that resides in electronic form and is related to the past, present, and future health status or health care provided to a subject of care. Currently, many medical information systems are used in healthcare organizations: Hospital Information System (HIS), Radiology Information System (RIS), Picture Archiving and Communication System (PACS), Laboratory Information System (LIS) and so on. These EHR data is stored in many different formats in a multitude of medical information systems. Typical formats include relational database tables, structured document-based storage in various formats, and unstructured document storage such as digitized hardcopies maintained in a classic document management system. Clinicians must rely on the comparison and inter-confirmation among those data to make more accurate clinical diagnoses, treatment plans and preventive measures in their daily work. But with the rapid development of modern medical information technology, the modality and amount of EHR data can be incredibly large in a digital hospital environment. It is a very tedious and inefficient work for clinicians to extract valuable information directly from the raw form of those complex multi-modal EHR data. As a consequence, effective visualization methods are needed to reveal the hidden information carried by them.

Since 1990s, much work has been done to visualize different kinds of EHR data. Most of those work only focused on the visualization of one or several kinds of EHR data partially. But actually, these data should not be isolated from each other for diagnosis purpose. It is far from enough to visualize them separately. We must treat them as a whole during visualization, i.e., make an integrated visualization. As the complexity and multiplicity of EHR data grows, this work becomes a big challenge.

Nowadays, there is almost no single working EHR system due to the research level of medical informatics. Most EHR data of an individual is generated and recorded during his visits in various hospitals. An unified structure to represent the multi-modal EHR data as various clinical acts is needed. If a method is formulated to organize those data according to the two dimensional act-time relationships, thus we can achieve the integrated visualization based on this method. After analysing the characteristics of each kind of EHR data, some appropriate visualization forms are designed and implemented as an integrated viewer. By this means, we provide the clinicians an overall scene of the patient's personal history, present health status, and future care plans to be held. The integrated viewer figure .1 can, not only help the clinicians in their daily work, but also is useful for telemedicine consultation

2.8 Integrated Lifetime Health Record (LHR)

A repository of information regarding the health of a subject of care, in a form able to be processed by a computer that is stored and transmitted securely and accessible by multiple authorized users using different applications. It has a standardized information model which is independent of an EHR system. Its primary purpose is the support of continuing, efficient and quality integrated health care and it contains information that is retrospective, concurrent and prospective.

An integrated Lifetime Health Record (LHR) is fundamental for achieving seamless and continuous access to patient medical information and for the continuum of care. These can be achieved through the convergence of Information and Communication Technology (ICT), medical content and health knowledge. Through this convergence, the patient LHR can be

shared among healthcare professionals and across healthcare facilities regardless of where the previous visit was. In contrast, the fragmented and paper-based medical records have significant limitations such as illegibility, unavailability, sheer physical volume (over time), difficult transferability and integration between providers and institutions, and the necessity to record the same data many times (duplication) on different documents (Roman *et al.*, 2006; Coiera, 2003; Pories, 1990). These problems become worse in situations where patients are able to freely visit any healthcare facilities for the same medical problem, and where the patients can be referred to an appropriate hospital anywhere in the country.

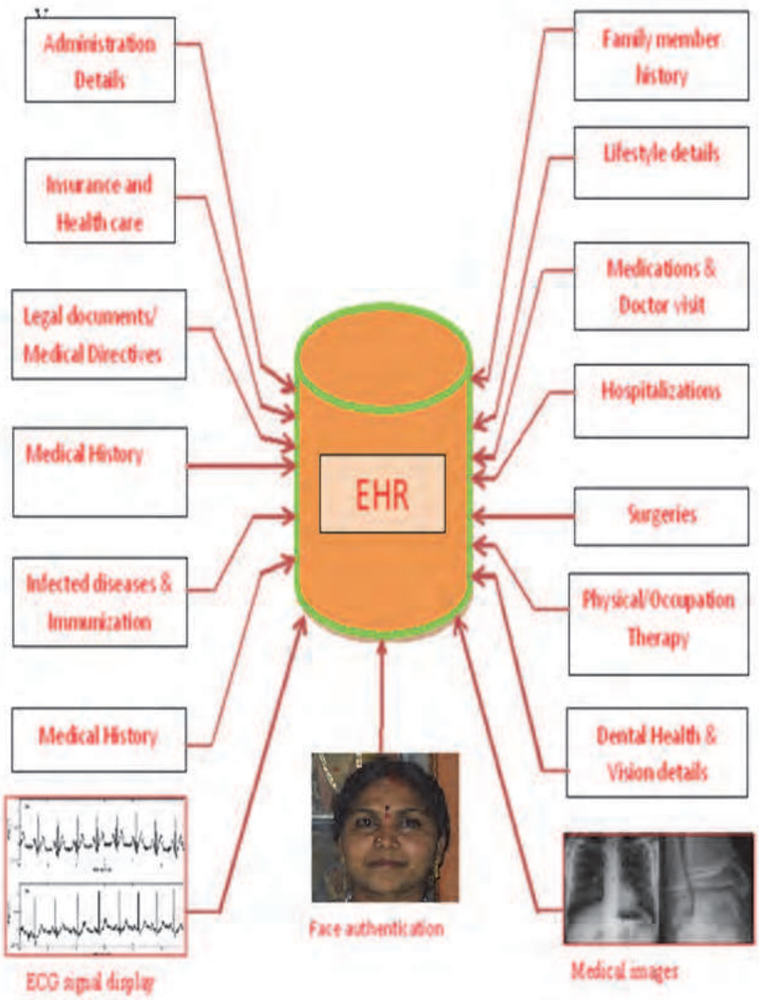

Fig. 1.

All countries in the globe, had taken initiatives to implement an integrated Electronic Health Record (EHR) system in their public health system either locally or nationwide. However, the aim has not yet been fully realised. The efforts are actively progressing towards finding the best approach in implementing integrated LHR on all levels of public healthcare facilities. Every stage of the development of the LHR initiatives had presented peculiar challenges. The best lessons are those of someone else's experiences. This chapter presents

an overview of the development approaches to be undertaken in developing countries in implementing a national LHR in the public health system. The major challenges elicited from the review, including integration efforts, process reengineering, funding, people and law regulation are to be considered. If suitable, this chapter will provide guidance for best practices to implement the LHR for developing nations.

This LHR is expected to aid rehabilitation by maintaining health record of the human subjects, predicting various abnormality well in ahead and suggest health tips which are easily adaptable, hence avoid any sudden /unexpected degradation of health.

Widespread adoption of LHR has the potential to help consumers and patients manage their own health, help doctors and hospitals to immediately gather relevant information to best treat an individual patient, improve tracking of chronic disease management, and provide for early detection of infectious disease outbreaks around the country. LHR also provide:

- Cognitive support for healthcare professionals and patients to help integrate patient specific data where possible and account for any uncertainties that remain. Help healthcare professionals to help integrate evidence-based practice guidelines and research results into daily practice.
- Instruments that allow providers to manage a portfolio of patients and highlight problems as they arise within both individual patients and populations.
- Rapid integration of new instrumentation, biological knowledge, treatment modalities, etc., into a "learning" healthcare system that encourages early adoption of promising methods but also analyzes all patient experience as experimental data.
- Accommodation of growing heterogeneity of locales for provision of care, including home instrumentation for monitoring and treatment, lifestyle integration, and remote assistance.
- Empowerment of patients and their families in effective management of healthcare decisions and execution, including personal health records (as contrasted to medical records held by care providers), education about the individual's conditions and options, and support of timely and focused communication with professional

Some telemedicine systems set up at high cost are lying unused due to lack of technical skill in handling. Today most PHCs have the basic infrastructure, including a personal computer, and a little additional investment on Web camera, speaker and Internet connection is all that is required. Using simple computer system based health portal, doctors at a remote location can view the specialist and share medical data. The patient can also interact with the specialist. It operates on any available connectivity. The twin option of store and forward, and real time consultation, gives the physician at one end the opportunity to raise his doubts, and the specialist at the other end, the flexibility to answer queries later, if both are not free at the same time. The platform also offers a multi-specialty telemedicine software solution, and is designed to enable quick and easy creation of telemedicine referrals.

The data in Electronic Medical Records prepared in this way is archived in a structured fashion. Further, the progressive medical history of the patient can be maintained. ECGs (electro cardiogram), X rays and other scanned diagnostic images can also be stored and viewed both by patient/remote hospital/ primary health centre as well as the super speciality hospital to facilitate better diagnosis. The audio-video exchange helps specialists talk to patients in remote locations. The specialist at a tertiary care hospital can make a better assessment of a patient's condition. The audio-video interface happens in real time and saves time on patient care despite distances. All the data sits on a central server.

3. Conventional approach to electronic health records

Today's predominant approach to implementing electronic health records involves purchasing an information system to automate, or script care processes. The vendor may provide a "starter set" but commonly the healthcare provider has to build its pick lists to support data capture, its decision or communication support logic, etc. As the provider uses the system, the electronic health record is created "for free" as a byproduct of using the automated care process (Stead & Hammond, 1988). When care takes place in an area of the practice that is not yet automated, the record catches up through "after-the-fact" data entry. The vendors often seek to increase the coverage of the record by providing a suite of applications that work together supported by a common database. Data elements are mapped into standard formats, such as Health Level 7 (HL7), for exchange with parts of the vendor's suite that are not well integrated into the database or products from other vendors. Much of that mapping is repeated practice by practice because exchange standards clarify what the data element is, such as a drug orderable, but not what it means, such as its chemical ingredients, dose-form and strength. This automation approach is workable if the patient population and the healthcare provider are largely self-contained and if the provider can afford IT staff to handle the setup and data mapping, and the clinical process expertise to adapt practice and systems to avoid unintended consequences. Even when all of those conditions fall into place, the provider does not obtain the quality and safety benefits of electronic records until the automation of each part of the practice is complete enough to fill out the record. Once the automation is complete, the information system makes the process rigid, providing a barrier to change over time as new business demands are experienced, as advances in biomedical science alter in substantive ways approaches to defining and confirming specific diagnoses and as communities of patients and providers alter their approach toward managing health problems., Automation and transaction processing have their place supporting well defined, small scale work processes that can be done over and over again with little variation — when specific treatment of disorders is clearly defined for some period, e.g. hernia repair, cardiac angiography, adjuvant chemotherapy for some malignancies. However, healthcare often attempts to extend the use of automation to more complex situations that require general problem-solving and both inter-dependencies and variations in work processes to manage combinations of disorders. Examples include: connectivity — linking people to each other and systems; decision support — making choices clear; and data mining — discovering relationships among data. Even when healthcare uses domains other than automation, they are often bolted onto a pre-existing core of automation. This core limits the range of scale of the data, knowledge, processes and roles that can be accommodated.

3.1 Features of the proposed model

1. To provide security to the medical data so that only authorized persons can view the details.
2. The data needed for the health record should be collected with a higher degree of flexibility.
3. The health record data collected should be organized and stored in a single file so as to reduce storage space needed.
4. Real time modification/updating of the data collected as it changes from episode to episode.

5. Compressing the medical data to reduce the memory required to store and to reduce the time of transmission.
6. Dynamic transmission and reception of the medical data between various terminals in the network of expert doctors and patient attendant at rural places.

3.2 Modular implementation of the model

Module 1

Module 1 of the Model implements an authentication algorithm that provides security to access the database of LHR. If a new record is to be created then a facial image of the person is captured from the integrated webcam and an authentication code runs using PCA based Eigen face recognition technique. To open an existing record, the facial image of the individual is again captured and is compared with the existing image templates that are already trained in the present database. Security to the database is provided in such a way that the contents of the record is accessible or viewed only when the individual facial features matches with the one that is already exist in the database. Here the individual health records that include wide range of health information regarding a human subject is created in a highly flexible and structured manner. This module includes the real time patient image capture process as soon as his record is created. The features of the facial image are stored as a set of coefficients along with other data.

Module 2

In this module the images present in the database are subjected to the advanced compression techniques to reduce the memory needed to store them in the Electronic Health Record of a person. Because of its excellent performance in medical image compression and various advantages such as reduction in computational efficiency, no boundary extensions, memory savings, parallel processing. Lifting wavelet Transform along with the SPIHT is applied to the images. The compression can be performed to various levels using the threshold that can be adjusted using the SPIHT. Corresponding decompression is applied at the receiver end to perform reconstruction of the images from the coefficients present in the file.

Module 3

Module 3 presents the application representation part for the authorized person to create, retrieve and modify the patient's database. Here the electronic health record of the person can be created which includes his medical history details, medical images, pathological reports, signal reports such as ECG, EEG etc. While opening the database of a person the authentication process is included so as to provide security to the subject's medical data. Flexibility is provided so that a person can enter any details and can view any details at a time so that he can provide the rest of the details at a later time if needed. The application is created in an innovative way so that it identifies the images of a particular patient from a set of images in the database converts them to intensity coefficients ,compresses them and stores them in the EHR.

Module 4

Module4 consists of the data representation part which includes representing various details of the subject as needed .This part also consists of the modification module which facilitates the dynamic updation/modification of any data in the medical record as it changes from the

patient's visit at every episode Various numbered options are provided to the application so that the person can view different details, images and signal reports by just entering the option provided beside the choice. The option for viewing the images in the subject's database is designed / written in a way that the coefficients from the specified positions will be collected and image is constructed from them. The data will be extracted from the file and arranged at corresponding position for the accurate representation of the dynamic data on the static form.

Module 5

This module consists of real time transmission and reception algorithms implemented in an innovative way so as to reduce the time of medical data transfer. The transmission algorithm is developed in such a way that only the dynamically changing data or the vital data which is to be diagnosed is sent to the Expert Center for immediate referral from the individual LHR. The reception algorithm then dynamically updates the LHR from the data received and rebuild the entire form for further inspection by the Expert physician.

Snapshots of the Lhr model developed

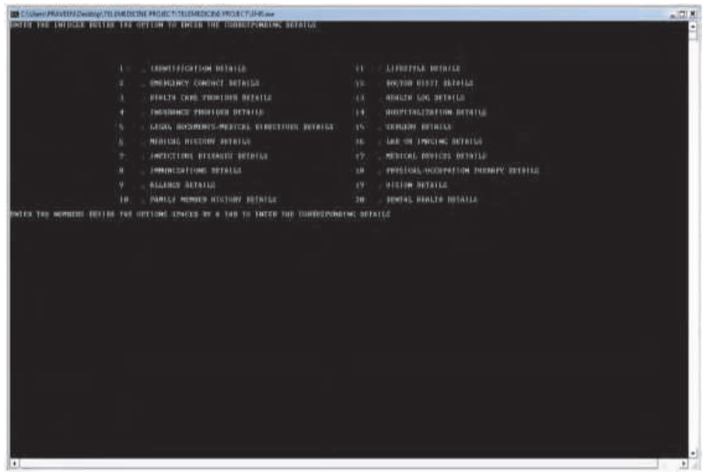

Fig. 2.

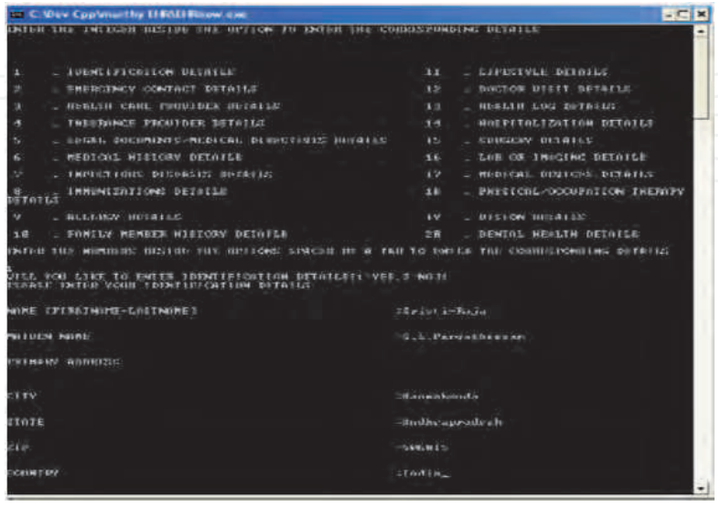

Fig. 3.

Fig. 4.

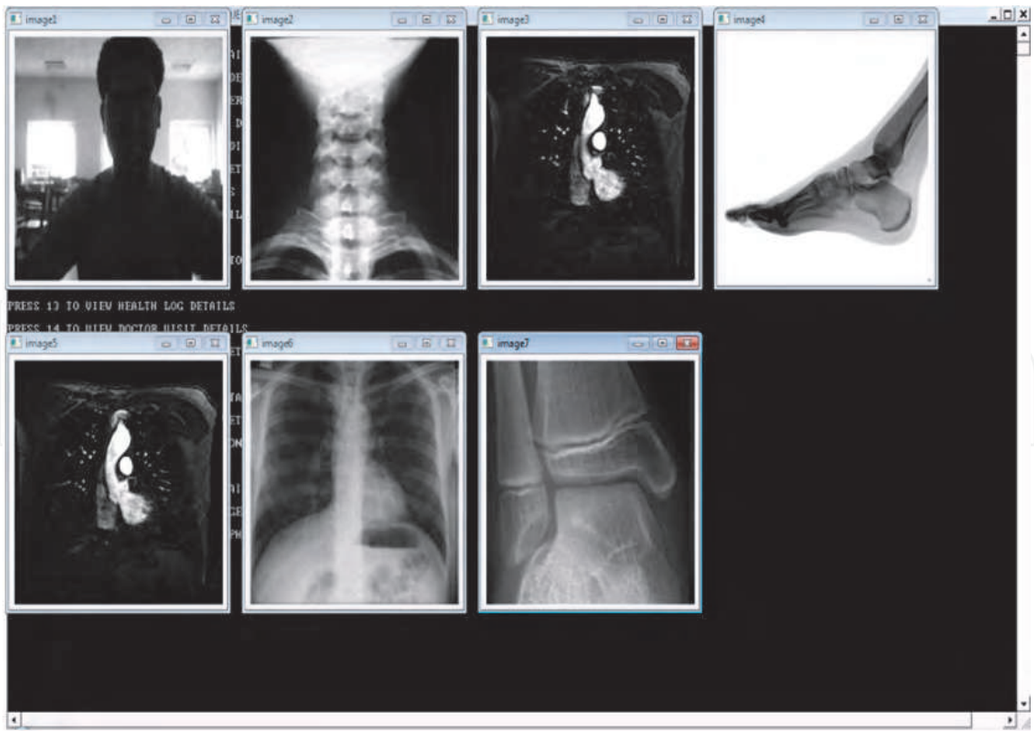
image1
image2
image3
image4
PRESS 13 TO VIEW HEALTH LOG DETAILS
image5
image6
image7

Fig. 5.

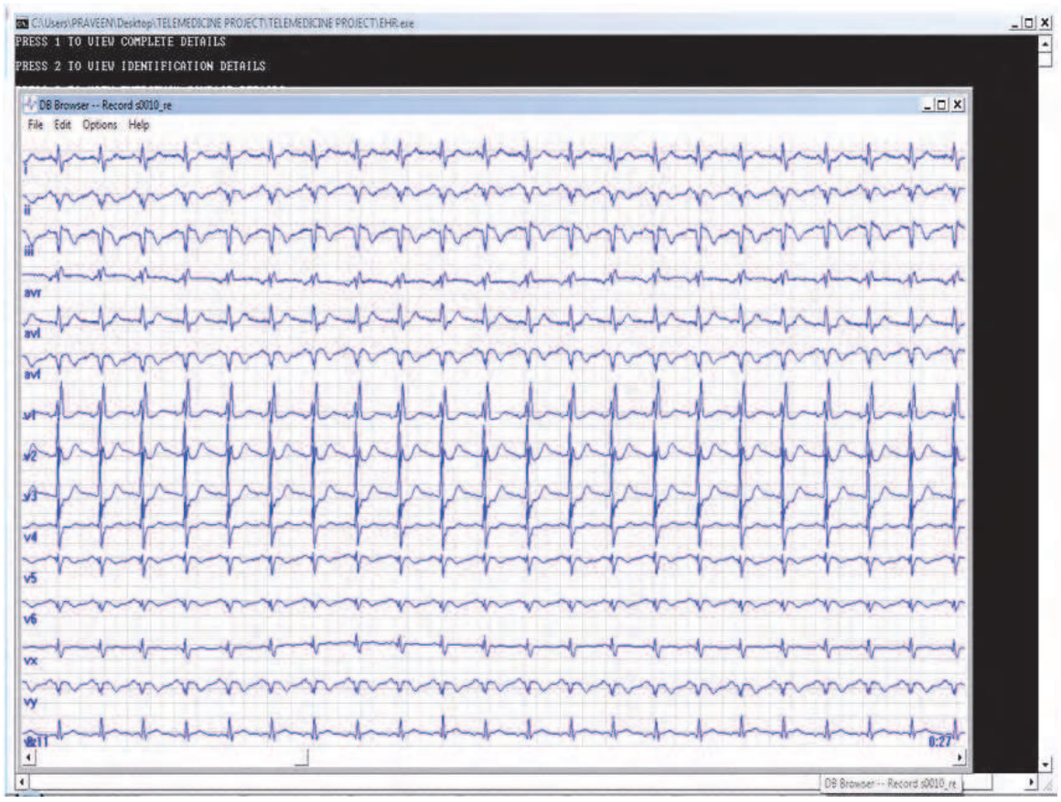

Fig. 6.

4. Conclusion and future scope

As this model developed and brought out as executable file form it easy for any level of user to create ,update, store and transmit using menu driven selection of various features in LHR. This model has been tested as an integrated module with all the features discussed above and is currently being adapted in a small scale at two of the local hospitals successfully. The presented model can further be made more secure by adding different security based algorithms along with encryption of the medical data to ensure higher degree of authentication to the EHR. Lossless compression models on heterogeneous medical data can be replaced in place of the existing algorithms. The model can be augmented with various transmission protocols such as wireless transmission which includes Bluetooth, infrared so as to increase the availability and flexibility for the users. It calls for a shift in the paradigm from thinking of the electronic health record as a by-product of automating practice, to thinking of it as a visualization of signals accumulated across scales of biology, time and geography.A paradigm shift from the current 'biomedical model' to a 'socio-cultural model', which should bridge the gaps and improve quality of rural life, is the current need. A revised National Health Policy addressing the prevailing inequalities, and working towards promoting a long-term perspective plan, mainly for rural health, is imperative.

5. Appendix

Lhr telemedicine form

A. Identification B. Emergency Contacts

Name (Last) (First) (Middle)				In Case of Emergency, Notify: Primary Contact Name (last) (First) (Middle)			
Maiden Name							
Primary Address				Relationship			
City	State	Zip	Country	Address			
Alternate Address				City	State	Zip Code	Country
City	State	Zip Code	Country	Home Phone		Work Phone	
Home Phone		Work Phone		Cell Phone		Email Address	
Cell Phone		Email Address					
Date of Birth		Sex: ☐ Male ☐ Female		In Case of Emergency, Notify: Secondary Contact			
Height	Weight	Eye Color	Hair Color	Name (last)	Name (middle)	Name (first)	
Race		Birthmark/Scars		Relationship			
Blood/RH Type		Special Conditions	Marital Status	Address			
Occupation				City	State	Zip Code	Country
Company Name				Home Phone		Work Phone	
City	State	Zip Code	Country	Cell Phone		Email Address	

Phone Number	Languages Spoken	In Case of Emergency, Notify: Medical Contact
Primary Health Insurance Carrier	Policy Number	Doctor *(Indicate Specialty)*
Secondary Health Insurance Carrier	Policy Number	

Phone Number	
Dentist	Telephone Number
Pharmacy	Telephone Number

C. Healthcare Provider

Healthcare Provider Specialty	Primary Care Physician ☐ Yes ☐ No	Phone	Emergency Phone No.(after hours)
Name		Email Address	
Group or Association		Fax	
Address		Web Address/URL	

City	State	Zip Code	Country

D. Insurance Providers

Insurance Provider Type				E-mail Address	Fax
Company Name				Web Address/ URL	
Address				Primary Insured Person-Name	Social Security No.
City	State	Zip Code	Country	Name of Employer	
Contact – Name		Phone		Address	
Identification-Group Number		Member(ID) Number		City / State / Zip Code / Country	
Contact Information-Phone		Emergency Phone No.(after hours)		Phone Number	

E. Legal Documents/Medical Directives

☐ Living Will ☐ Durable Power of Attorney for Healthcare ☐ Power of Attorney				Fax			
Document Location (Physical Location)				Contact (Name of person who has access to the document)			
Location Name (for example Bank of America)				Address			
Address				City	State	Zip Code	Country
City	State	Zip Code	Country	Contact Information			
Legal Representative (Name of person who you have assigned legal authority)				Home Phone	Cellular Phone		
Address				Pager	E-mail Address		
City	State	Zip Code	Country	Work Phone	Work E-mail Address		
Contact Information				Fax			
Home Phone		Cellular Phone		Date Filed			
Pager		E-mail Address		Organ Donation:			
Work E-mail Address		Work Phone		Organ Donor ☐ Yes ☐ No	State Where Registered		

☐ Living Will ☐Durable Power of Attorney for Healthcare ☐ Power of Attorney				Fax			
Document Location(Physical Location)				Contact (Name of person who has access to the document)			
Location Name (for example Bank of America)				Address			
Address				City	State	Zip Code	Country
City	State	Zip Code	Country	Contact Information			
Legal Representative (Name of person who you have assigned legal authority)				Home Phone		Cellular Phone	
Address				Pager		E-mail Address	
City	State	Zip Code	Country	Work Phone		Work E-mail Address	
Contact Information				Fax			
Home Phone		Cellular Phone		Date Filed			
Pager		E-mail Address		Organ Donation:			
Work E-mail Address		Work Phone		Organ Donor ☐ Yes ☐ No		State Where Registered	

F. Medical History(Check appropriate)

☐ Acquired Immunodeficiency Síndrome(AIDS) or HIV Positive:	Date of Onset	☐High Blood Pressure	Date of Onset
☐ Arthritis		☐ Hypoglycemia	
☐ Asthma		☐ Jaundice	
☐ Bronchitis		☐ Kidney Disease	
☐ Cancer		☐ Low Blood Pressure	
☐ Chlamydia		☐ Mental Retardation	
☐ Diabetes		☐ Pain or Pressure in Chest	
☐ Dizziness		☐ Palpitations	
☐ Emphysema		☐ Periods of unconsciousness	
☐ Epilepsy		☐ Rheumatic Fever	

☐	Eye Problem		☐	Rheumatism	
☐	Fainting		☐	Seizures	
☐	Frequent or Severe Headaches		☐	Shortness of Breath	
☐	Glaucoma		☐	Stomach Liver or Intestinal Problems	
☐	Gonorrhea		☐	Syphilis	
☐	Hearing Impairment		☐	Tuberculosis	
☐	Herat Condition		☐	Tumor	
☐	Hemodialysis		☐	Thyroid Problems	
☐	Herpes		☐	Urinary Tract Infection	
☐	High Blood Cholesterol		☐	Other	

G. Infectious Diseases

Disease	Age	Date	Remarks
Chicken Pox			
Hepatitis			
Measles			
Mumps			
Pertussis /Whooping Cough			
Pneumonía			
Polio			
Rubella			
Scarlet Fever			
Other			

H. Immunizations:

	Booster 1	Booster 2	Booster 3

Immunization for	Age	Date	Age	Date	Age	Date
Diptheria						
Hepatitis B						
Measles						
Mumps						
Pertussis/Whooping Cough						
Polio						
Rubella						
Smallpox						
Tetanus						
Tuberculosis						
Typhoid						
Other						

Allergy/Sensitivity Type *(include medications foods environmental or other)*	Reaction	Date last Occurred	Treatment

Display for ECG/XRAY/NMR/CT

J. Family Member History

	Mother	Father	Sibling(s)	Grandparent	Children
Enter ages of relatives					
If deceased, indicate age and cause of death					
Check all items that apply for their present state of health or any illnesses they have had					
Alcoholism					
Arthritis					
Asthma					
Cancer					
Diabetes					
Emphysema					
Glaucoma					
Herat Condition					
Hemodialysis					
Hepatitis					
High Blood Cholestrol					
High Blood Pressure					
Kidney Disease					
Mental Retardation					
Rheumatic Fever					
Seizures					
Smoking					
Stomach Liver or Intestinal Problems					

Stroke					
Thyroid Disorders					
Tuberculosis					
Tumor					
Other					

K. Lifestyle

☐ Alcohol	Drink(s) Per Week	Number of Years
☐ Smoking	Pack(s) Per Day	Number of Years
☐ Exercise	Type(s) of Exercise	Days Per Week

L. Health Log (Noninfectious major illnesses. Include pregnancies and childbirth)

Date Diagnosed	Doctor	Nature of Health Problems	Age at Onset	Condition Status	Remarks *(Such as, medications, special tests, x-rays, length of hospital stay, surgery and so on)*

M. Medications

Note: Include all prescription medications, (such as nitroglycerin) over-the-counter medications (taken on a regular basis), vitamin supplements, and herbal remedies

N. Doctor Visits

Date	Doctor	Reason	Diagnosis

O. Hospitalizations

Hospitalization Type (includes emergency room visits)		Diagnosis
Admission Date	Discharge Date	
Doctor		
Hospital		
Reason		Complications

Hospitalization Type (includes emergency room visits)		Diagnosis
Admission Date	Discharge Date	Admission Date
Doctor		
Hospital		
Reason		Complications

P. Surgeries

Date	Doctor	Results

Hospital	
Surgical Procedure	
Description	Comments

Date	Doctor	Results
Hospital		
Surgical Procedure		
Description		Comments

Q. Lab or Imaging (Examples: X-ray, MRI, Mammogram)

Test Type	Date	Test Type	Date
Requesting Doctor	Administered by	Requesting Doctor	Administered by
Reason		Reason	
Result		Result	

Test Type	Date	Test Type	Date
Requesting Doctor	Administered by	Requesting Doctor	Administered by
Reason		Reason	

Result	Result

R. Medical Devices (Examples: pacemaker, insulin pumas, breathing devices)

Device Type	Doctor	Device Type	Doctor
Hospital	Date	Hospital	Date
Reason		Reason	

S.Physical/Occupation Therapy

Therapy Type	Start Date	Stop Date	Frequency	Therapist

T. VISION

Date of Visit	Physician	Date of Visit	Physician
Vision RX		Vision RX	

Date of Visit	Physician	Date of Visit	Physician
Vision RX		Vision RX	

U. Dental Health

Date of Visit	Dentist	Problems	Resolution

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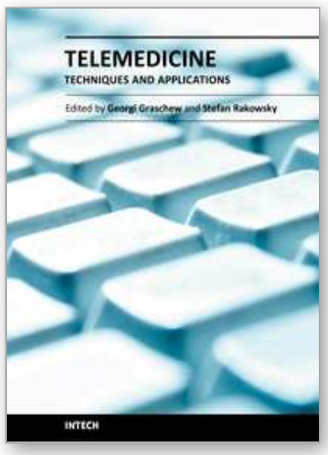

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Telemedicine is a rapidly evolving field as new technologies are implemented for example for the development of wireless sensors, quality data transmission. Using the Internet applications such as counseling, clinical consultation support and home care monitoring and management are more and more realized, which improves access to high level medical care in underserved areas. The 23 chapters of this book present manifold examples of telemedicine treating both theoretical and practical foundations and application scenarios.

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