TELE-HEALTH

The Modern Face of Healthcare

Editors

Hameed A. Khan
M.M. Qurashi
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January 2007

Commission on Science and Technology for Sustainable Development in the South

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COMSATS Headquarters
4th Floor, Shahrah-e-Jamhuriat, Sector G-5/2, Islamabad.
Ph: (+92-51) 9214515-7, Fax: (+92-51) 9216539
URL: http://www.comsats.org.pk, email: comsats@comsats.org.pk

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4th floor, Shahrah-e-Jamhuriat
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email: comsats@comsats.org.pk
Website: www.comsats.org.pk
Ph: (+92-51) 9214515-7, (+92-51) 9204892
Fax: (+92-51) 9216539

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ACKNOWLEDGEMENT

This book has been written in a manner that it can be readily comprehended by non-technical persons. It covers discussions on various modes of providing healthcare services over far off and distant places, through present-day communication means.

In writing this book, the authors have consulted and utilized several important monographs on tele-health by well established subject experts. In doing so, various books and article have been referred to and excerpts quoted, in particular from the book titled "Essential of Telemedicine and Telecare" by Anthony C. Norris. The authors of this monograph wish to acknowledge their indebtedness to these learned subject-experts and researchers.

TELE-HEALTH
The Modern Face of Healthcare

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ACRONYMS

ADSL	Asymmetric Digital Subscriber Line
AIM	Advanced Informatics in Medicine
AMA	American Medical Association
ATM	Asynchronous Transfer Mode
BA	British Airways
BPS	Bits Per Second
CAD	Computer-Aided Design
CDC	Center for Disease Control
CME	Continuing Medical Education
CODEC	Coder-Decoder
CPR	Computerize Patient Record
CSS	Clinical Support System
CTI	Computer Telephone Integrated
DDS	Digital Data System
DPI	Dots Per Inch
ECG	Electronic Cardiography
EDI	Electronic Data Interchange
ETM	EuroTransMed
EU	European Union
FAQs	Frequently Asked Questions
FTP	File Transfer Protocol
Gbps	Gigabits per second
GIF	Graphical Interface Format
GMC	General Medical Council
GP	General Physician
GPOs.	Group Purchasing Organizations
GUI	Graphical User Interface
HIMSS	Healthcare Information Management and Support System
HMOs	Health Maintenance Organizations
HTTP	Hypertext Transport Protocol
ICTs	Information Communication Technologies
IEEE	Institute of Electrical and Electronic Engineers
INAHTA	International Network of Agencies for Health Technology Assessment
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISRO	Indian Space Research Organization
ISO	International Organization for Standardization
ITU	International Telecommunications Union
LAN	Local Area Network
LHP	Lifetime Health Plan
MASH	Mobile Army Surgical Hospitals

MCPHIE	Mass Customized/ Personalized Health Information and Education
MCU	Multipoint Control Unit
MedCERTAIN	MedPICS Certification and Rating of Trustworthy and Assessed Health Information on the Net
MRI	Magnetic Resonance Imaging
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
PET	Position Emission Tomography
SAF	Store and Forward
SCSI	Small Computer Systems Interface
SKU	Stock Keeping Unit
SPECT	Single-Photon Emission Computed Tomography
STARPAHC	Space Technology Applied to Rural Papago Advanced Health Care
TCP/IP	Transmission Control Protocol/Internet Protocol
UNDP	United Nations Development Program
UNESCO	United Nations Education Science and Cultural Organization
URL	Uniform Resource Locator
VSAT	Very Small Aperture Terminal
WHO	World Health Organization
WWW	World Wide Web

FOREWORD

One of the key indicators to judge government's performance is its developmental interventions in the healthcare sector. Particularly in a country like Pakistan, which has observed exponential population growth and is faced with multifaceted socio-economic challenges. Under such conditions telehealth becomes an important tool to deal with the intensifying health care issues.

The task of providing every individual with an equal opportunity to healthcare information and clinical resources is an uphill task. Pakistan is not different from other developing countries that have scarce clinical and medical resources in terms of human resources and infrastructure. The Government is fully cognizant of the benefits that new technologies can offer and of its responsibilities towards providing healthcare to all the provinces, regions, and communities across the country that is economically accessible. Tele health is a key to achieving these goals.

It is heartening to see that COMSATS has taken a lead to implement, the first of its kind, Tele health project in Pakistan, to which I am a witness as well, since I myself presided over its launching ceremony last year. It is encouraging to note that such innovative projects are taking place by our 'strategic partners for development' like COMSATS. The present Government is implementing a lot many developmental projects in the health sector, in particular, the development of National Health Management Information System, program for family planning & Primary Health Care, and HIV & AIDS control. I am of the firm opinion that these and many other projects of healthcare can directly benefit us a lot by developing and implementing a system and network of Telehealth.

It is now for the developing countries like Pakistan, to make concerted efforts in bringing about the soft change in the mindsets of health professionals and practitioners in adapting to newer and feasible ways to providing healthcare. This particular book by COMSATS on *Tele-Health: The Modern Face of Healthcare*, I am sure was compiled and written keeping in view the same goal, since it delicately touches upon the various issues and challenges for implementing Tele-Health systems. It is a good source of information, which draws the readers' attention by firstly defining what Tele-Health exactly means, in how many different ways it can be exercised and later by narrating what challenges and issues are faced in order to establish such networks or systems.

What I like about this book is that it encapsulates learning and knowledge in most simple form, by presenting case studies of various other projects of Tele-Health implemented in other countries of the world. I find this compilation easy to read and comprehend, since it does not have many technical jargons. Lastly I would appreciate all those who have worked so hard in the compilation of this book.

(Muhammad Nasir Khan)
Federal Minister for Health
Government of Pakistan

PREFACE

Telehealth is a relatively newer concept as far as most of the developing countries are concerned. It is fast gaining popularity and is being reckoned as one of the befitting means to rendering healthcare services cost effectively and to a wider geographic spread. It is imperative to take advantage of the present day technologies, especially the information communication technologies (ICTs), which have enormous potential to providing healthcare in the wake of population explosion, high levels of illiteracy & malnutrition, and scarce medical and clinical resources. The use of telecommunications and computer technology to provide medical information and clinical services at a distance is particularly beneficial to the communities and masses stuck in the far off or geographically stranded areas. Telehealth systems make specialized medical consultation in access of such communities that are otherwise underserved and resource poor; it most importantly saves them time and cost.

Due to the rapid advancements taking place every now and then in the technology, more and more clinical applications can now be performed via telehealth networks. Broadly defined, telehealth/telemedicine is the use of advanced telecommunications technologies for the purposes of making diagnoses, conducting research, transferring patient data, and/or improving disease management and treatment in remote areas. The emphasis is on use of telecommunications technologies at remote sites. Telehealth has the potential for ameliorating seemingly intractable problems in healthcare such as limited access to care among segments in the population especially the geographically disadvantaged, uneven quality of care, and cost inflation.

The idea to compile a manuscript on telehealth came across when COMSATS' Telehealth Service was being inaugurated in July 2006. The Chief Guest on the occasion, Mr. Muhammad Nasir Khan, the Federal Minister for Health, advised COMSATS to consider capturing its expereinces in a book. We are very grateful to his Excellency for his guidance, and acting upon his advice we have brought out this monograph. This monograph highlights telehealth in the various forms that it exists; it encapsulates the offerings of ICTs in healthcare and it hints out the hard core facts limiting this healthcare delivery mechanism. This book also provides a good review of the endeavors being made across the globe to establish telehealth systems/ networks, as it presents case studies extracted from the earlier publications by some subject-experts. In the end, some key recommendations are given as directions for establishing telehealth as a source of effective healthcare delivery mechanism.

It has been particularly taken into consideration to keep the language of this monograph simple and comprehensible to non-technical individuals. It was aimed to evoke interest and create general information about telehealth. Also, an effort has been made to draw the attention of the relevant quarters in the governments, in particular in the developing countries, to divert their efforts towards and focus in the field of telehealth as it provides fast and easy access to healthcare services.

The subject of telehealth is vast and has various facets to it. I open heartedly accept hereby that not all the areas of telehealth have been detailed in this monograph in a precise and balanced form, particularly the technological aspects, however these have just been touched upon briefly.

Last but not the least, I would like to acknowledge and appreciate the individual efforts and hardwork of my colleagues from COMSATS, Mr. Irfan Hayee, Miss Noshin Masud, Miss Huma A. Khan, Dr. Azeema Fareed and Mr. Nisar Ahmad for helping me in exploring, structuring and compiling this manuscript on telehealth.

In particular, Mr. Irfan helped compile and review the initial chapters of the book that defines and explains various forms of telehealth, the history and the potential as well as limitations of this innovative service. Miss Huma studied and presented the challenges faced in implementing telehealth at enterprise level as well as compiled the case studies on telehealth from the developed world. Miss Noshin advocated the role of telehealth in addressing the issues confronting developing countries and pointed out areas that need to be accounted for while undertaking such initiatives. Also, I must thank the team of Dr. M.M. Qurashi, Mr. Irfan Hayee, Mr. Imran Chaudhry and Ms. Nageena Safdar for carefully editing, proof reading and bringing out this manuscript in a book form.

(Dr. Hameed Ahmed Khan, H.I., S.I.)
Executive Director, COMSATS

1. BACKGROUND

The population at global scale continues to increase: that of the more developed regions as a whole is hardly changing and virtually all population-growth is occurring in the less developed countries. As per estimates, the world population has reached the figure of 6.5 billion in the year 2005, 5.3 billion of whom live in developing countries. Developed countries account for only 19% of the total world population. (World Population Prospects, the 2004 Revision, population division, United Nations, 2005).

The ever growing population, especially in the developing countries is putting the respective states and governments under tremendous pressure. The growth in population implies supplementary demand of resources, whereas the developing countries are already finding it difficult to meet their present needs. The developed world is better off, since, (i) its population growth is under control, i-e 0.3 % increase annually, and (ii) it is making apt use of science and technology to address multifaceted issues. On the other hand, population in the developing world is increasing almost five times as fast, at 1.4% annually, and the situation of the least developed countries is even more horrifying with an increase of 2.4% annually.

The world population as a whole is faced with increased poverty, food insecurity, social & economic disparities, digital divide and deteriorating climatic situation. 20% of the population in the developed nations consume 86% of the world's goods, while approximately 790 million people in the developing world are still chronically undernourished, almost two-thirds of whom reside in Asia and the Pacific Region. According to UNICEF, 30,000 children die each day due to poverty, and they die quietly in some of the poorest villages on earth, far removed from the scrutiny and the conscience of the world (Progress of Nations 2000, UNICEF, 2000). Being meek and weak in life makes these dying multitudes even more invisible in death; that is about 210,000 children each week or just under 11 million children under five years of age, each year (State of the World's Children, 2005, UNICEF).

In the field of healthcare, the situation is no different. The picture is eqully bleak since the number of healthcare professionals to address health issues of the growing population is far less than needed.

Increasingly, telehealth and telemedicine are attracting the attention of planners, hospital administrators, clinicians, private firms and evaluators. In making it possible to provide health-services over a distance. Various communications technologies could change the way our health-care system is organized. However, the telehealth programs tried out in various industrialized countries have not yet yielded enough data on the relevance, utility, efficacy, efficiency, reliability and costs of, or associated with, the use of these technologies.

2. INTRODUCTION

2.1 Information-Technology in Our Lives

The process of information-exchange has passed through various phases during the long history of human civilization. In the early times, useful applications were made of smoke signals, cave drawings and quill pens, with a view to exchange information from person to person and place to place. Centuries afterwards, a significant development in this regard took place with the invention of the printing press, which can perhaps be called the earliest form of "Information Technology". This was the first solid evidence of the development of a tool for mainly expanding and speeding up the distribution or transfer of information to far-flung areas and to a large number of people and places.

Substantial time passed by till another worth mentioning development took place in this direction. The development, which followed, changed the whole concept of the process of exchange of information. This important phase in the history of Information-Technology is due to the discovery and application of newly developed tools, such as electricity, telegraph, telephone, wireless, radio, television, etc. It was quite noticeable that history of information went through drastic and sudden changes. Every discovery of a new process or invention of a new tool/gadget was followed by a development in the field of Information-Technology. The form/mode of flow of information changed its shape from written words of printing materials to audio signals received through telephone, wireless and radio. Much more comprehensive exchange of information took place in the form of visual signals of television. During this important change in the mode of information-transformation, it was noted that the flow of information was making a much greater impact on the recipients, as compared to previous technologies.

No worthwhile further development could be observed in this process for a long time, till the development of an important machine, called the 'computer', now operation with high-speed solid-state semi-conductors & switching devices. Computers not only transmit information from one place to another and from one source to another, but also more importantly, with the help of computers the information could be transmitted in a more organized way and could be manipulated/reshaped according to the specific needs. This was perhaps the first useful combination of 'information' and 'technology', which ultimately resulted in what can be justifiably called, the "Information Age".

In the twenty-first century, cost-effective communication- infrastructure and information-systems are not just luxuries, but a necessity. In fact, they are strategic factors, critical to the developmental process and to reduction of poverty. Information Technology has become the "Knowledge Tool", which is essential for the management of a country's economics. By involving IT, governments can transport, store, retrieve and disseminate information far more efficiently and hence improve the productivity of their nations.

Information Technology is perhaps one of the most dynamic and creative branches of present technologies. Experience shows that there is a continuous supply of new problems. These problems are not only new, but also time-targeted. Not only that these problems are to be taken care of immediately, but it becomes even more complicated because both technology and problems keep on changing with time.

It is interesting and remarkable to note that information technology is not only extremely pervasive, but also its history is recent. There is no doubt that, in a short span of time, information-technology has reduced this world to a global village. Previously existing physical boundaries, in education, commerce and communications, have almost vanished. New scholarly, economic, political, spiritual alliances have been forged due to the role played by information-technology to access and retrieve the required information from widely distributed and diverse sources. Multinational companies and world-wide businesses have come into being, due to the extremely useful role played by information-technology. This is because of its enhanced communication-capability, increased access and streamlined financial operations. All this has resulted in what we call today "High-Tech Industry". This stage of development owes a lot to the dramatic surge in the development of information technology tools, systems and processing, with new semi-conducting devices, and some of the novel uses /applications of the valuable information obtained by using information technology. The entirely new segment of e-commerce has taken birth and has revolutionized the whole process of business and economy.

It may be mentioned at this juncture that cellular phones, personal computers, world-wide access, satellite delivery systems – some of the tools of information technology used presently — are rapidly becoming interwoven in the fabric of our life-style. Some of the important changes that have taken place include, information-access in terms of time and scope, change of mode of information according to the format one requires, and to learn, work and play according to time and place of our preference. In short, the impact of information-technology is enormous on our day-to-day living. It has changed the way we think and we live.

Revolutionary advances in IT reinforce economic and social changes that are transforming business and society. A new kind of economy, the "information economy" is emerging, where trade and investment are global and firms compete with knowledge, networking and agility. A corresponding new society is also emerging, with pervasive information-capabilities that make it substantially different from an ordinary industrial society: much more competitive, more democratic, less centralized, better able to address individual needs, and friendlier to the environment. A hundred years ago, a strong industrial sector meant an economically strong country. Today, the information revolution plays a pivotal role in any country's economic success. Technology is having a global impact: It is changing the world around us. And if we do not adapt to the changes, we would be left behind.

The impact of information technology in terms of its utility for business and economic growth is enormous, but its applications are not just limited to business and commerce. The applications of I.T in meeting societal needs are matchless too; this is especially true in the education and health sectors. The coupling of information technology with modern communications has taken us to new horizons in improving the quality of life, making us more caring, capable and competitive. Today it has become relatively more convenient for one to access healthcare and educational resources.

2.2 Information-Technology Meets Medicine

As discussed above, the past few years have seen enormous changes in the way information is gathered, stored, manipulated, analyzed, and disseminated. These developments in Information Technology (IT) provide opportunities for both government and the private sector to rethink how they produce and deliver products and services and, in many cases, to rethink what their basic function should be. Although the opportunities are exciting, there are also significant challenges to making new technology and ideas work. Two of the key challenges are: coping with the investment of time, resources, and stress to put changes in place, and dealing with the need for wide collaboration and cooperation, especially in a governmental context.

Recent and continuing developments in computers have enormously increased the ability to store information and to share it remotely. In addition, advances in computer software now permit various kinds of manipulation, analysis, and even problem-solving to be done by computers, through the techniques of artificial intelligence and expert systems.

With all these developments and progress taking place in the field of information technology and, especially, the coupling of IT with latest communication-technologies, the applications of information and communication-technologies in our day-to-day life has grown many folds. In terms of providing basic amenities of life, ICT has a major role to play. Its not only food and shelter that, today, is reckoned as basic amenities of life; rather it's the healthcare and basic education that is considered equally or even more important. Applications of IT, rather ICT, in the field of healthcare have landed us in a new arena – the "Tele-health" arena. Tele-health is a modern concept that is fast receiving acceptance, for its effectiveness and efficiency in the delivery of clinical services as well as healthcare as a whole.

2.3 Tele-Health: The Concept

As technologies and their applications have expanded, so has the conceptualization of the place of technology within health and within society as a whole. The broadening impact of technology is reflected in the changing definitions and models. Definitions that embody an increasingly broad generic conception, rather than narrow definition by technology or discipline, are becoming prevalent and are probably most useful. Telehealth can be defined as:

> *"The use of information and communications technology to deliver health-services and exchange health-information when distance separates the participants."*

Telehealth is a more refined concept, which encapsulates various healthcare services. The major application of Telehealth is telemedicine, which is confined to providing clinical services to the needy. The term 'telemedicine' is gradually going out of favour and being replaced by tele-health. The reason behind this shift in emphasis is the changing practice. Earlier, most telemedicine services comprised provision of consultation by medical doctors, using the medium of telecommunication to bridge the distance. Then, the transfer of medical information was the immediate goal of such service.

With the increasing involvement of non-medical professionals in the provision of healthcare, the term 'tele-health' came more in use than before. It describes this useful expansion beyond the confines of clinical medicine. Although experience and changes in practice are at the root of this shift, it has been accelerated by falling costs and increased access to equipment, as well as by more general facilities such as the Internet.

Further definitions of Tele-health can be: the use of information and communication technologies to transfer healthcare information, for the delivery of clinical, administrative and educational services.

A more thorough definition of Telehealth was given by World Health Organization in 1997, which states:

Telehealth/telemedicine is the delivery of healthcare services, where distance is a critical factor, by healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of diseases and injuries, and for the continuing education of healthcare-providers as well as research and evaluation, all in the interest of advancing health of individuals and their communities.

The scope of Telehealth as given in the above definition is extensive. It may include provision of administrative healthcare-information that recognizes the use of telematic services to transfer demographic and operational information that may have little or no clinical content. Similarly, while distance-learning courses for healthcare professionals are covered by the banner of tele-health, components of these courses may concentrate on health-policy or other non-clinical topics.

Considering the above definitions the applications of Telehealth are practically limitless. It perfectly addresses the problems where distance, time, geography and cost are a barrier to effective healthcare services. Present-day technologies now greatly help in improving the effectiveness and efficiency of clinical as well as health educational services. The applications of Telehealth range from monitoring health from homes, providing clinical/diagnostic services in battle fields, marginalized and remote areas, to providing healthcare information and education through virtual means for the large interest of public-health.

Provision of healthcare information over internet further gives rise to more complex definitions and usage of ICTs in the fields of healthcare. The term E-health is at times interchangeably used with Telehealth.

Narrowing down the focus on some of the fundamental applications of Telehealth, the definitions and their utility are explained and defined below. The basic applications are the provision of clinical or diagnostic services to patients and the needy at a distance; the services if imparted to and from a medical facility is referred to as telemedicine and, simply put, if the service is imparted from a medical facility to the residence of end-users then it is called tele-care.

Telemedicine

The prefix tele derives from the Greek meaning ‘far’ or ‘at a distance’ or ‘remote’. This prefix to medicine signifies the attribute of a service that is rendered from far across, provides medical information and services using telecommunications that also includes transferring of electronic medical data from one location to another.

Precisely stated, telemedicine can be defined as: Use of information and communication technologies to transfer medical information for delivery, clinical and educational services.

This definition sheds light on the purpose of the provision of tele-medical services. Treatment is clearly stated as a prime objective, but so is education, revealing an increasingly common role for telemedicine, one that is not directly associated with treatment. The medical information may include images, live video and audio, video and sound files, patient medical records, and output-data from medical devices. The transfer may involve interactive video and audio communication between patients and medical professionals, or between those professionals without patient participation. Alternatively, it may simply describe the transmission of patient-data, either from monitoring devices (telemetry) or from medical histories (electronic patient records).

Tele-care or Home Monitoring

By convention, the term ‘telemedicine’ is usually confined to remote medicine in primary and secondary care, and emergency locations. In contrast, the term tele-care is often used to describe the application of telemedicine to deliver medical services to patients in their own homes or supervised institutions.

Tele-care or home-monitoring is slightly different from telemedicine, since it is related to providing medical services to a different target-group of people. This group includes people with long-term chronic conditions, such as mental illness, disability or simply old age, which reduce their freedom of movement. The definitions of tele-health and telemedicine take into account tele-care, since neither says anything about location. The more common approach, however, is to define tele-care separately, as follows: Tele-care, utilizes information and communication technologies to transfer medical information for the diagnosis and therapy of patients in their place of domicile.

To some up, we have:

Box - 1

Telemedicine

- A system of health care delivery whereby physicians examine distant patients through the use of telecommunications technology (Preston 1993)
- That subset of tele-health that deals with medical diagnostic and treatment services (PRHCIT 1996)
- The delivery of health-care services, where distance is a critical factor, by health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, and for the continuing education of healthcare providers as well as research and evaluation, all in the interests of advancing the health of individuals and their communities (WHO 1998)

Tele-Health

- The application of information technology and telecommunications for diagnostic and treatment services, educational and support services and the organization and management of health services (including health information management and decision support systems) (PRHCIT 1996)
- A health delivery system which provides health-related activities at a distance between two or more locations using technology-assisted communications (ANZTC 1996).

Health Informatics

- An evolving scientific discipline that deals with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge (Health Informatics Society Australia 1999)

Health Telematics

- Computer services offered from or through telecommunications systems. As such, telematics ranges from all forms of dial-up services, through the Internet, and on to broadband applications such as Full Service Network (ETHOS, 1999)
- A composite term for health-related activities, services and systems, carried out over a distance by means of information and communications technologies, for the purposes of global health promotion, disease control and healthcare, as well as education, management and research for health (WHO 1997)

continue...

...continued

- The combined use of informatics and telecommunications as applied to health delivery (G7 Information Society Initiative 1999)

E-Health

- The combined use in the health sector of electronic communication and information technology (digital data transmitted, stored and retrieved electronically) for clinical, educational and administrative purposes, both at the local site and at a distance (Mitchell 1999).

E-Commerce

- Every type of business transaction in which the participants (i.e. suppliers, end users, etc.) prepare or transact business or conduct their trade in goods or services electronically (NOIE, 1999)
- Business-to-business electronic communication (Mitchell 1999).

Information Economy

The new world of social and commercial interaction, brought about by advances in information technology (NOIE, 1998)
The Australian government's mission in preparing Australians for the information economy is "to ensure that the lives and work of Australians are enriched, jobs are created and national wealth is enhanced through the participation of all Australians in the growing information economy" (NOIE 1999)

Information Society

- The term used to describe a society and an economy that makes the best possible use of new information and communication technologies. In an Information Society, people will get the full benefits of new technology in all aspects of their lives: at work, at home and at play (Information Society Commission, Dublin, 1999).The vast array of new and emerging technologies has implications for all aspects of our society and economy. The prospect of an Information Society is associated with key changes and challenges to the way in which we do business, how we learn and how we spend our leisure time. Similarly, new technologies are changing and challenging healthcare systems. It is critical that these technologies are harnessed to achieve the greatest health benefit for all.

Wooding, Robert. (2001). "National Telehealth Plan for Australia and New Zealand": http://www.health.gov.au/internet/hconnect/publishing.nsf/content/7746b10691fa666cca257128 007b7eaf/$file/teleplan.pdf

2.4 Applications of Tele-Health

The compass and classification of tele-health practice has grown with the development and continuous progress in information and communication technology. At present, we can categorise four closely related types of Telehealth activities, as stated by A.C. Norris in his book 'Essentials of Telemedicine and Telecare':

- Tele-Consultation;
- Tele-Education;

- Tele-Monitoring ;
- Tele-surgery.

These Telehealth activities are defined and briefly touched upon as follows:

Tele-Consultation

Through Tele-consultation activity, the patient at the distant end benefits by receiving medical or clinical consultation from a general practitioner over a telecommunication medium. This Telehealth activity directly benefits; the patients. tele-consultation activity helps out the patient through time and space utility to support clinical decision-making and is the most frequent example of tele-medical procedures. Studies have shown that tele-consultation accounts for about 35% of the usage of telemedicine networks; the remaining time is devoted to tele-education and to administration.

It is important to understand that often another healthcare worker is present with the patient during the consultation, and the involvement of two healthcare professionals modifies the one-to-one patient-carer relationship found in conventional consultation.

Tele-consulation may be conducted in two ways:

i. Real-time Tele-consultation: this may take place between two or more healthcare professionals without patient involvement or between one or more healthcare professionals and a patient. But the significant thing is that this sort of activity takes place in real time for interactive feedback (i.e. consultation). This can be done through a telephone conversation between two physicians to obtain a second opinion, and also via a videoconferencing link.
ii. The second way is called the store-and-forward method. Through this method, the patient-related information is stored in some form and sent to healthcare provider(s) for their advice and consultation.

Tele-Education

Internet provides a huge amount of information through online sources. Any online information that has aspects related to medicine or healthcare serves us as good virtual resource for tele-education. These virtual health- resources can be used to impart education to a larger group of medical students, healthcare providers, care givers, general physicians and even specialist doctors. These tele-health links deliver educational material through tele-education, that is education using present-day telecommunication technologies. There are different types of tele-education, which depend on who is the recipient and what the purpose of the transmission is:

- Clinical education from tele-consultation;
- Clinical education through the use of Internet;
- Academic study through the use of Internet;
- Public education through the use of Internet.

Tele-Monitoring

Tele-monitoring can be defined as the use of a telecommunications link to collect routine or repeated information about the patient's health condition. There are two types of acquisition process:

i. Manual , in which case, the patient records the data and transmits them by telephone, facsimile or a computer/modem system;
ii. Automated, in which continuous data can be submitted, either in real time or in store-and-forward mode.

The main objective of tele-monitoring is to keep continuous surveillance on a person's health. It is to decide if and when an adjustment to the treatment or prescription is needed for the patient. The adjustment can thereafter be communicated verbally or through other telecommunications means.

There are a number of factors that result in the instable condition of the patient. The most common is forgetting to take prescribed medication. Tele-monitoring is also successful in potentially life-threatening circumstances, such as heart conditions (tele-cardiology). For example, ECGs routed from elderly patients at home to their GPs and ultrasound scans transmitted from new-born infants to paediatric cardiologists.

Tele-monitoring has immense importance in tele-care, especially for elderly and disabled people confined to their own homes or institutions.

Tele-Surgery

The concept of tele-surgery is still in its initial stages. The term Tele-surgery, as obvious from the word itself, defines conducting surgery on the human body (in particular) over a distance, using telecommunications means. The two ways of practising tele-surgery are:

i. Tele-mentoring, which describes the assistance given by specialists to surgeons carrying out a surgical procedure at a remote location usually through video and audio connection. Tele-education is an important aspect of tele-mentoring.
ii. The second way is called tele-presence surgery, which guides robotic arms to carry out remote surgical procedures. The links allow large movements of the surgeon's hands to be scaled down, so that very precise, tremor-free incisions can be made. Movement scaling is used by doctors to repair damage inside blood-vessels.

3. BRIEF HISTORY OF TELE-HEALTH

Various forms of telecommunication and information technologies have evolved with time. On these bases, we can identify four phases of the development of tele-health corresponding to the use of these technologies (Table-1).

Table – 1: Phases of Tele-health Development

Development phase	Approximate time frame
Telegraphy and telephony	1840s-1920s
Radio	1920 onwards till 1950s
Television/space technologies	1950s onwards till 1980s
Digital technologies	1990s onwards

These phases can be related to a number of developments and activities to deliver health related information in the past to the concerned persons, these may be as:

- Clinical or healthcare information over telephone, or broadcasting it over radio stations.
- Marconi's invention of the radio-telegraph in 1897, which was used during the American Civil War to send casualty lists and order supplies.
- Closed-circuit television service begun in 1955; used in hospitals
- The Nebraska Psychiatric Institute developed a two-way link with Norfolk State Hospital, 112 miles away, in 1964 with further extensions in 1971. This project is one of the first of many examples of tele-psychiatry.
- The National Aeronautics and Space Administration's (NASA) efforts in tele-health began in the early 1960s when humans began flying in space. Physiological parameters were telemetered from both the spacecraft and the space suits during missions.
- Project STARPAHC - Space Technology Applied to Rural Papago Advanced Health-Care. STARPAHC aimed at providing medical care to astronauts in space and to the Papago Indian Reservation in Arizona. This service was carried out through a van that was equipped with a variety of medical instruments, including electrocardiograph and x-ray. The van was linked to the Public Health Service hospital and another hospital with specialists, by a two-way microwave tele-health and audio transmission.
- In the later parts of 1970s, Alaska Satellite Biomedical Demonstration Program and various other Canadian projects were begun, to serve far-flung areas.
- The North-West Tele-health Project set up in Queensland, Australia, was the only major tele-health project outside North America until 1990. This project was designed to serve rural communities. The project-goals were to provide healthcare to people in five remote towns, south of the Gulf of Carpentaria.
- The first truly international tele-health program, known as Space Bridge, was implemented by NASA. It was done to provide relief to people after a terrible earthquake jolted Armenia in 1988 and cased severe devastation.

3.1 Present-Day Tele-Health

Information Communication Technologies have revolutionized the way we communicate and coordinate our day-to-day activities. In the field of healthcare, it impacted significantly too. The benefits of tele-health were already demonstrated globally by the late 80s, it simply increased the quest for more research and development in the field and the need to address the healthcare issues on national and regional scales. The transition from analogue to digital communications and the accompanying role of computers and information technologies such as mobile telephones, were clearly major drivers in increasing the pace.

With the wide access and commercialisation of Internet services globally, this has become the mainstay for Telehealth activities since 1994. The term Telehealth became more widespread after various health-resources were made available to medical and non-medical healthcare professionals. Internet became a source of distant healthcare education to many.

Nowadays, the focus is to build and benefit from networks of tele-centres across wide geographic areas. A clear shift in the way healthcare is governed by governments is visible, since the scope of Telehealth activities has grown from providing clinical services to maintaining public- health records, anticipating and addressing seasonal and cyclical diseases and epidemics. Health Information Management and Support Systems (HIMSS) are being built for good governance and to improve the reflection-time to meet emergencies.

As stated above, Telehealth activities have grown not only in size, but also in scope. Streaming audio and video through internet has raised the prospect of remote consultation and surgery via the superhighway. Tele-surgery, or as we can say conducting surgical operations from far across, has been made possible with sophisticated technologies available to us today. The number of tele-consultations has grown steadily. Now specialist opinion, or as we can say second opinion, is available in almost every field of medicine. Specialist consultations are provided in fields like dermatology, gastroenterology, general medicine, and cardiology. These services are provided through both store and forward methods (asynchronous) as well as through live consultations (synchronous method). For example, in the USA, Allen and Grigsby report that nearly 40,000 tele-consultations were performed in 1998 in more than 35 different specialties. Around 70% of the episodes used interactive video, the rest using pre-recorded or non-video technologies.

The number of tele-consultations is, of course, small compared with the total number of consultations by conventional face-to-face methods. The figures exclude tele-radiology, which remains the single most popular (and pre-recorded) application with more than 250 000 consultations in the USA alone in 1997. This latter number reflects the long-term standing of tele-radiology as one of the few tele-health specialties that has entered mainstream healthcare. As a consequence, tele-radiology receives full reimbursement under the USA's Medicare healthcare scheme.

3.2 Drivers of Tele-Health

3.2.1. Technological Drivers

We can identify three main drivers under this heading:

- Computing and information technology;
- Network and telecommunications infrastructure;
- Technology-led societies.

The following subsections comment briefly on the respective features that apply to tele-health.

Computing and Information Technology

The developments taking place in the field of Information and Communication Technologies have led to the expansion in access as well as improvements in existing services for all walks of life. Developments in videoconferencing technologies, other then the diminishing equipment costs, i.e. increased power on the desktop and ease-of-use have contributed to the tele-health services becoming more efficient. On the flip side, it is important to keep in mind that the likelihood of tele-health systems to become obsolete is high, since the use of many interfaces can be a major cause of incompatibility and malfunctioning.

Network and Telecommunications Infrastructure

Naturally, it is not just the power on the desktop that drives the advance of IT, but the ability to share information over local and wide area computer-networks. The development and convergence of communications technologies, and the bewildering array of new transmission-protocols, have led to major improvements and opportunities in tele-health services, as in many other areas of information exchange.
Low-performance, modern technologies, based on copper-wire transmission, have been supplemented by faster media and technologies using fibre-optic cables. The installation of national fibre-optic (Tl, T3) backbones (e.g. the NSFNET and its successors in the USA) has promoted an expansion of tele-health services in several countries.

Even so, the need for greater bandwidth has led to the introduction of new protocol, such as asymmetric digital subscriber line (ADSL) and asynchronous transfer mode (ATM), and major developments in wireless and satellite technologies. Several of these broadband technologies are competing for attention, a fact that will inevitably lead to lower prices and added value.

Technology-Led Society

The pace of technological change feeds on the appetite of society for ever greater speed, convenience and quality. Nowhere is this appetite so voracious as in the USA, which has been the kitchen for innovation and progress in technology in general, and information technology in particular. Microsoft, IBM, Intel, Motorola, CISCO, Netscape and Sun Microsystems are just a few of the chefs that come to mind.

The USA's national taste for technology is coupled with other national characteristics, e.g. an aptitude to develop strategy on an expansive scale ('think big') and organise resources to implement the strategies (the 'can do' or 'no problem' philosophies). National space and defence programmes are typical examples. The development and role of medical technology is another, more pertinent, illustration.

As a consequence, the USA has been at the forefront of advances in tele-health, not just in research but in the all-important follow-up of moving tele-health into the healthcare mainstream.

3.2.2 Non-Technological Drivers

Non-technological drivers can be just as important as those that harness technology. We can distinguish seven key factors that have helped, and are helping, the development of tele-health:

- Extension of access to healthcare service;
- Healthcare provision for travellers;
- Military applications;
- Home tele-care ;
- Cost reduction;
- Market development;
- Health policy and strategy.

Some details on these are given below:

Extension of Access to Healthcare Services

Extending healthcare access to individuals and communities who have limited, erratic or negligible access to such services has motivated tele-health developers from the earliest times to the present day. Beneficiaries include patients who live in rural areas with few healthcare professionals to look after them, and residents who inhabit areas that are cut off from normal transport at certain times of the year by bad weather. Isolated communities in parts of Australia and the USA provide examples of the former, as does Canada, which also provides an exemplar of climatic difficulties. Tele-health services can overcome the 'tyranny of distance' presented by these conditions and reduce medical and economic risks. However, deprivation of healthcare services is not confined to those who choose to live outside of urban areas and the concentration of medical facilities. Tele-health services are now on offer to the occupants of penal and mental institutions, thereby avoiding the costs and dangers of transporting patients to external health facilities. As we have seen, a similar rationale lies behind the provision of tele-care services to elderly or handicapped people in their own homes.

Healthcare Provision for Travellers
Even public having permanent access of first class medical services finds it difficult to avail these during travels. As we all travel more often, so health- care in travelling is now of greater importance.

The classical quandary arises at sea where no crew-member possesses more than elementary first-aid experience. In such circumstances Radio-medicine helps as back up system, by providing advice for treatment or redirecting towards a port with required facilities.

Telemedicine can do a little better. Transmission of ECG or blood pressure readings from telemetric tests, or visual or X-ray images from a videoconferencing system, to a shore-based physician can improve diagnosis and lead to better care. It may also prevent possibly expensive or dangerous diversion to port. Similar problems can occur on flights, which is an increasingly common mode of travel.

Military Applications
Military applications can be comparable to travellers for providing healthcare; patients are prevented from normal access to first-class medical facilities. However, in military circumstances the ratio of conventional disease to emergency conditions is often the reverse from civilian life. Furthermore, many of the emergencies are likely to be serious injuries and of a different type (e.g. gunshot or explosion injuries) than of the civilian world. The priority to restore the health is increased with the need to return the combatant to active duty as soon as possible.

Telemedicine and videoconferencing are therefore offering better opportunities for sorting of the patients in emergencies and life-saving treatment involving filmless radiology and tele-surgery where field- surgeons are mentored in real time by consultant specialists.

Also, soldiers are exposed to diseases for which they have little immunity during aggressions in different countries, add to this the fear of chemical warfare, Mobile Army Surgical Hospitals (MASH) and their equivalents can thus benefit from medical tele-technology.

Home Tele-care
Tele-care has also got more attention since the mid-1990s, as the ageing population increases in all developed nations. This increase in proportion of older people also increases the occurrence of chronic disease and long-term conditions. Tele-care significance is of two ways: mostly elder people prefer to live in their own homes and home-care can thus be provided, in spite of expensive hospitalization; also it is possible to reduce home visits by talking to a patient through a video-link and receives up-to-date information and vital signs, especially if these patients live in rural or remote

areas.

In this way, the nurse could see more patients in a day. Alternatively, the hospital management may reduce the number of nursing staff, to save salaries.

Cost Reduction

Particularly, by implementing telemedicine the medical and economic risks to provide healthcare to patients in rural areas can be reduced (see above) and it is easy to provide low-cost speciality services to remote areas where full-time staffing is impossible.

Very few telemedicine projects actually demonstrated the cost-effectiveness of telemedicine services. A survey of many medical disciplines and applications depicts that in general, tele-radiology, tele-psychiatry, and home and prison tele-care are mostly cost effective.

Market Development

It is difficult to reveal overall cost-benefit ratio of tele-medicine, due to its uncertain operational cost in spite of low capital-cost of its equipment. Therefore, still tele-medicine market has not "taken off".

To survive, telecommunications providers should enhance the size of overall market or differentiate their product from the other prevailing products in the market. For this purpose, the providers have an interest to promote the telemedicine technology in user-friendly areas, such as tele-care.

Health Policy and Strategy

Until now, policy makers just issuing comforting statements and lag far behind in demonstrating any serious enhancement to shape up tele-medicine development, so that the public could safely leave healthcare to their competent hands.

On the subject of telemedicine, some progress can be seen in countries like USA. In UK, it has been forecast that the future of tele-medical requires the concerned authorities to include telemedicine in their thinking and planning for future services, so that the policy care set the framework for local solutions.

To become a developed nation by 2020, the Malaysian government has embarked upon a Multimedia Super Corridor Programme, which has seven flagship projects destined to revolutionalize government, business, education and health.

To enhance investment and to speed up the development of the infrastructure and solutions, a legal framework of cyber-laws has been drafted in 1977 when different tele-health projects were initiated. In spite of 1997 Asian Financial Crisis, the Vision strategy and implementation will achieve the project goals.

Box - 2: Tele-Health: Strategic Drivers

The 1990s have witnessed the convergence of key drivers for the uptake of tele-health:

An ageing population

- A gradual, long-term increase in life expectancy has increased both the overall number of older people and the proportion of the population comprising older people.
- A substantial proportion of chronic disabling conditions associated with ageing are potentially preventable or can at least be postponed, and are not an inevitable part of growing old.

A paradigm shift from treatment to prevention and care

- Health care in the future will probably be more about managing chronic conditions than responding to acute illness. In 1995, for the first time, more people died of chronic illness than from an acute illness.
- Increasing numbers of people are living for longer periods with severe disability. This is the result of better survival rates in infancy and after major trauma, as well as living longer with chronic health conditions or progressive and terminal illness.

Changing models of care

- Future health-related services and their models of delivery will reflect the shift from treatment to prevention and care.
- It is predicted that the number of people going into hospital and their length of stay will continue to reduce. Over time, healthcare is likely to be delivered in the home or at the workplace.

Expanding diagnosis and treatment options

- Improved imaging
- Increased capacity for care and monitoring in the home and community

Improved information technology and communication

- Dramatic improvements in the performance of information technology and communications technologies, accompanied by declining costs
- Expanding applications

Market forces

- Strong perception within industry that the health sector is a major market sector for generic information technology and communications applications

Pressures to reduce healthcare costs

- Healthcare spending is on an upward track
- Increasing capacity to diagnose and treat resulting in growing levels of service provision

Consumer demands

- Individuals are better educated, and know more about health and healthcare
- Consumers are increasingly empowered and make informed choices about their own healthcare, and expect to be part of the decision process

Urbanisation and globalisation

- Declining rural populations accompanied by increasing concern about service levels "in the bush"
- Disappearing national boundaries
- Widening gap between rich and poor nations, regions and economies

Wooding, Robert. (2001). "National Telehealth Plan for Australia and New Zealand": http://www.health.gov.au/internet/hconnect/publishing.nsf/content/7746b10691fa666cca257128007b7eaf/$file/teleplan.pdf

4. TELE-HEALTH: OPPORTUNITIES AND LIMITATIONS

This section discusses the benefits and limitations of tele-health. The disadvantages we acknowledge here are essentially operational ones that commonly arise in practice. Finally, we probe some more strategic barriers to development of tele-health that are inherent in current thinking about healthcare delivery.

4.1 Benefits and Limitations of Tele-Health

In our previous sections we have shed some light on the origins, development and drivers of tele-health, and have categorized its various types; this in turn has brought forward many of the benefits and limitations. In the following pages we will try to summarise these factors in a concise manner.

4.1.1 Principal Benefits of Telemedicine

We can summarise the principal benefits claimed for telemedicine as follows:

- Improved access to healthcare;
- Access to better healthcare;
- Access to continued education;
- Increased accessibility to information-resources;
- Improved communication between healthcare providers;
- Optimizing resources vis-a-vis healthcare;
- Reduction of costs.

Improved Access to Healthcare: One of the major drivers of tele-health is extending access of healthcare to poorly served rural communities and disadvantaged populations. This socio-economic thrust has given a strategic focus to tele-health programmes in several countries.

One of the benefits that are exhibited by tele-health projects is the reduction of travel and disruption that is a source of immense convenience to the patients. Savings in, time for both patient and healthcare-providers, and faster access to care are similarly easy to demonstrate where they occur.

Access to Better Healthcare: Wherever there has been a lack of healthcare facilities, any type of healthcare provision is welcome; but access to better healthcare addresses the improvement in the quality of care. A direct benefit of tele-health is the remote access that a patient and his/her physician have to specialist advice, specially when it is not available locally.

Early intervention, more flawless care (including care-protocols) and better monitoring of progress are additional advantages of tele-health links, involving a primary-care doctor, hospital specialist and a community- care nurse. The monitoring process may also entail tele- monitoring.

Access to Continued Education: The discussion on tele-education earlier dealt with this issue at length and we need add little here. A situation worth consideration that has not been mentioned previously is the provision of healthcare-courses, perhaps with awards, for the general public.

Several countries are promoting a subsidised scheme for low-income families to help them gain home-access to the Internet. Low-income groups are often those identified as being at greatest risk from disease, due to socioeconomic conditions and lifestyles. The Internet could be used for promotion of health with web-sites targeting both children and parents. There are endless prospects for the use of internet; it could also be used to advertise health-programmes, and facilities such as local fitness centres, incentives could be provided to encourage take-up.

Increased Accessibility to Information Resources: The continuing education benefit referred above is an example of the ‘push’ technology. Increased access to information resources is concerned more with individuals attempting to ‘pull’ information from the Internet and/or other sources to answer specific questions. The individual mentioned here maybe a doctor accessing ‘case-oriented’ information in an electronic library, accessing the literature with an electronic search-engine, or visiting a web site to find out about events of interest or the latest medical equipment. On the other hand, in the individual could be a patient wanting information on a medical condition, times of surgery-hours, or advice on how to stop smoking.

Improved Communication between Healthcare Providers: The shift to digital information offers numerous benefits for the carers and their patients. Digitised data, such as a patient's previous history, X-rays, test-results and notes for the current episode, are readily transmitted electronically, using standard protocols and technologies, such as email. Discharge letters are similarly available without delay. Digital communication provides healthcare-information that is more accurate, more complete and more timely—attributes of quality that lead to better access and better healthcare.

Optimizing Resources viz Healthcare: Where better access to healthcare and access to better healthcare cater to one dimension of the healthcare scenario, the optimization of healthcare resource utilization is the other. It is uneconomic to replicate resources in several centres when these resources have infrequent use.

A preferred approach is, therefore, to set up a smaller number of resource-sites and make these available to potential users via tele-medical links. The arrangement can apply to the disposition of both specialist and expensive equipment, such as MRI machines, as well as to ‘walk-in’ centres for patients with minor complaints. Any spare capacity in the telehealth-network can be used for a range of tele-education purposes.

Reduction in Costs: This is the most debatable benefit, since few protagonists of tele-health have been able to show cost-savings in an obvious manner. One of the reasons is that tele-health trials often involve few presenting patients and it is not clear how costs and benefits will scale.

Clear savings in cost have been demonstrated in tele-radiology, which has been around long enough for practitioners to create a marketable service and optimise its operation. There is also evidence for economic benefits from tele-health in home-healthcare and the care of prison inmates.

Box - 3: Direct Service Benefits of Tele-Health

- Improved access and utilization of comprehensive telemedicine services that address community based health and wellness priorities.
- Enhanced scope of regional health professional retention and recruitment and retention strategies
- Increased community participation and influence over access to the health system
- Reduced patient and health system travel burden – particularly for the elderly and parents with young children who have to travel long distances for access to medical services.
- Improved peer-to-peer interaction and team-based approaches to regional care.
- Decreased isolation for patients at distant points of care, using tele-visitation services.
- Improved community-based health service training and education capacity.

4.1.2 Limitations of Tele-Health

Our survey of the reported limitations of telemedicine includes the following:

- Poor relationships between Patient & healthcare provider;
- Poor relationships between Healthcare Professionals;
- Need for Additional training;
- Interference in Organizational Affairs;
- Difficult Protocol Development;
- Incompatible Technology;
- Under-utilisation.

Poor Relationships between Patient & Healthcare Provider: Technology can be intrusive as well as a source of conflict between the patient and the healthcare provider, particularly if the electronic devices require constant adjustment or if they breakdown. On the other hand, then involvement of a second healthcare worker can also enhance the patient-healthcare provider relationship. Poorer relationships are therefore not routine and are often confined to the start-up stage of a link.

The concerns of patients regarding the suitability of the equipment and the confidentiality of the consultation, reservations of both patient and physician about the possibilities of litigation; are fears that need to be overcome with time.

Poor Relationships between Healthcare Professionals: Tele-health can represent a threat to preferred practices. The likelihood of such threats is increased if one or more of the clinical participants is over-enthusiastic and tries to persuade unconvinced colleagues into using the link, without due discussion or preparation.

Need for Additional Training: Education and training are key constituents in a successful tele-medical application. As the system develops and new staff is taken on board; start-up and ongoing requirements must be considered. In order to alert healthcare providers of the prospects of tele-health and to convince sceptics of its value, the educational needs must be addressed.

The training requirement covers the setting up and use of the equipment, the tele-consultation process, and the production of appropriate documentation for these tasks and for recording the consultation procedures and outcomes.

Interference in Organizational Affairs: The introduction of new technologies and methodologies mostly lead to some disruption and concern about the short- and long-term results.The US Western Governors' Association Telemedicine Action Report lists several reasons for resisting change, including:

- Fear that telemedicine will increase the workload;
- Fear that telemedicine is market, rather than user-driven:
- Fear of technological obsolescence:
- Lack of skills and the need to acquire them;
- Lack of agreed standards.

These concerns all represent clinical risks and should be included in risk- assessment at the time of considering a proposal for a telemedicine service.

Difficult Protocol Development: Protocol or pathway development is one of the most important and most time-consuming aspects of the introduction of a tele-medical application. The value of a care-pathway is premised on the basis of multidisciplinary involvement; which is both strength and a weakness. The strength comes from the holistic and integrated view of care that arises from multidisciplinary team-work. The weakness follows from the unequal status of the participants (e.g. doctors and nurses) and the shear logistical difficulties of getting staff together to work, on and agree to the pathway.

The very process of protocol development of pathways and may give rise to various hidden resource-requirements. The development should therefore be seen as an advantage, in that it identifies and costs what is needed to run a tele-medical service properly.

Incompatible Technology: Problems are most likely to occur with techno-phobic patients (or healthcare workers). Their occurrence is therefore most with elderly patients whose lack of confidence increases their confusion. Careful preparation and equipment maintenance can minimise most difficulties.

Under-Utilisation: We have discussed the "optimizing of resources viz healthcare" as an advantage in the previous section. On contrary to that, in case a tele-medical link is installed and then remains unused, or the link is so successful that local healthcare workers become so proficient that they make the links redundant, then it would give rise to the under-utilization of resources.

4.2 Barriers to Progress

We have discussed above some operational limitations of tele-health, we now address factors (external to tele-medical practices) that will nevertheless hinder its development unless they are either removed or simplified. Several of the barriers arise from the ways in which the remote link between the healthcare provider and the patient changes the way that healthcare professionals work and assume responsibility for care.

This list of barriers focuses on specific issues in the following categories:

- Telecommunications infrastructure and standards;
- Efficiency and Effectiveness of Cost;
- National policy and strategy;

Following is simply an outline of the constraints these factors can impose on practice and development of tele-health.

Telecommunications Infrastructure and Standards: There is a need for telecommunications link between a patient and a remote healthcare provider, in order for tele-health and telemedicine to work. This link is usually a physical connection, but more increasingly it is a wireless circuit. Most links between, rather than within, structures are multipurpose, i.e. they are installed as general electronic highways to handle many different services. The bandwidth of the shared link, i.e. its capacity to carry tele-medical data, is a potential barrier to the practice of tele-health.

Restricted bandwidth and poor adherence to interoperability standards can be significant barriers to progress in tele-health. The bandwidth will be low if it is based on analogue rather than digital transmission or, if it is digital, shared with many other users, as is the Internet. These circumstances will limit the type of information that can be transmitted. For example, it may not be possible to transfer large images, such as X-rays, or even to establish usable videoconferencing links. Another technical factor that can lead to difficulty is the incompatibility of operating standards or protocols, especially across international boundaries, so that transmitted data are either not received or are unintelligible to the receiving station.

Efficiency and Effectiveness of Cost: The efficiency and effective of tele-health costs is a major subject of debate, within the tele-health community. The debate is based on two arguments; first that the majority of pilot studies were (and still are) funded by government and academic grants and have been concerned more with technical and clinical feasibility than with cost-effectiveness, and second is difficulty to evaluate the cost benefits of a tele-medical application. It is often hard to cost advantages such as increased convenience, higher quality, more equitable access etc., public and private regulation may prevent the full optimization of service and income generation opportunities.

Commercial companies have been discouraged from entering the field of tele-health due to the uncertain cost-benefits. This will remain a major barrier to progress till better ways to demonstrate cost effectiveness are found.

National Policy and Strategy: While health-policy is a driver for progress of the tele-health, its absence can act as a barrier. Certain countries, like the USA and Australia have realised the importance of healthcare planning involving tele-health and have begun to evolve policies and enact laws that encourage its development. Other countries, e.g. the UK, have limited to issuing guidelines and advice.

The different approaches may possibly be a reflection of the perceived values and applicability of tele-health within a country. Coordinated action of the planners is more likely to produce more rapid and successful development than a discontinuous approach.

5. TELE-HEALTH: ISSUES & CHALLENGES

In order to run a proper tele-health program one needs to be cognizant of the issues and challenges facing it, which includes amongst others:

5.1 Confidentiality and Privacy

Tele-health represents a new approach to health-care, with the potential for improving accessibility and reducing costs. Over the years, technology has become increasingly interactive, cheaper and standardized. Despite this, the uptake of technology has been low. One of the main reasons is that the introduction of telematics in health-care requires more than technology and software—organizational and cultural change is required as well. A suggested approach is based on the principals of service quality and quality management, to produce a partnership between the users and developers of new technologies. This will, in turn, make it possible to bring user-validated requirements into the design of the system and create feelings of ownership and motivation on the part of users, in order to prepare their environment for the change. The methodology has been effectively used in various projects of the Telematics Application Program of the European Commission.

5.2 Ethical and Legal Aspects

Taking into account ethical and legal issues is important for meaningful and effective tele-health program. These aspects, as narrated by A.C. Norris in his book 'Essentials of Telemedicine and Telecare', are as follows:

5.2.1. Patients, Physicians and the Internet: The implications of the Internet have permeated this text, suggesting that it will be a major influence on the way we practise medicine and the way in which patients assume increasing responsibility for their own care. As testimony to its impact, a recent poll has shown that more than 98 million US adults have sought healthcare information online and 75% of those who have access to the Internet use it to find health-related information. This explosive growth brings threats as well as opportunities, and many clinicians are unprepared, both technically and mentally, for the new patient power and the ethical and legal dilemmas that the new paradigm produces.

For example, physicians now find that they need to provide online services, such as web sites, direct email communication, and question-and-answer sessions, to help interpret the information that patients acquire. They are also concerned about the amount of time they need to spend with patients to explain the shear mass of data and the way in which the Internet is reducing the asymmetry of the patient-doctor relationship.

An oft-expressed threat is the uncertain origin and quality of information offered in a frequently anarchic and unregulated environment. Another perceived threat that remains high on the agenda of concerns is the privacy and confidentiality of personal information. Patients (as well as web-site developers!) have shown themselves sceptical of claims that information is secure and immune to attack. Patient-trust is a key-issue and, once it is lost, it is difficult to recover.

However, the convenience of electronic communication means that, despite the many ethical concerns of clinicians, medical advice, email diagnosing and prescribing will become increasingly common, as will the automatic monitoring of conditions and the transmission of test-results. While services will be tailored to individual needs and customised-care becomes the norm, the web will also be used to host treatment-regimes such as, disease management programmes and care-protocols, and the depersonalisation of these activities could result in the loss of vital contextual clues and a reduction in the quality of care. A further move in the direction of impersonal care is the tendency of physicians to form groups so that the group is online rather than an individual.

Governments must be aware of and respond to these pressures by educating the public and providing a legal framework in which unethical and irresponsible practice can be exposed and the offenders punished. This framework should involve healthcare-professionals and industry, and should encourage them to construct ethical codes and act in a self-regulatory manner in order to minimise malpractice and maximise patient benefits.

5.2.2. Ethical Guidelines for Patient-Information: Informed users quite naturally expect clinical information on the Internet to be of high quality, i.e. accurate, timely and based on evidence. That is, they expect the content of a web-site to be governed by the same principles as scientific and professional publications. Thus, they want to know the names and affiliations of the authors, their declared interests and the date of publication of the web information, as well as the names of any sponsors.

Naive users have less critical faculty and are more easily persuaded of the validity of what they read on a web-page. However, all users require information to be presented in ways that facilitate its retrieval, so that they can draw the maximum benefit from it. They also need the assurance that any information they themselves provide will remain private and confidential.

Several organizations have endeavoured to enshrine these principles in guidelines or codes of ethical practice for the construction of Internet web-sites. The Hi-Ethics consortium is a voluntary group, which aims to: unite the most widely used consumer health-Internet sites and information providers whose goal is to earn the consumer's trust and confidence in Internet health services.

The objectives of Hi-Ethics are to:

- Offer Internet services that reflect high quality and ethical standards;
- Provide health-information that is trustworthy and up to date;
- Keep personal information private and secure, and employ special precautions for any personal health information
- Empower consumers to distinguish online health-services that follow these principles from those that do not.

Members agree to adhere to these objectives, to be open in their interactions with consumers and to provide mechanisms for consumer- feedback on any relevant issue. They must also recognise and point out the limitations of health web-sites and state that these cannot fully replace the human interaction of a conventional patient-physician relationship.

The intention of Hi-Ethics is to provide Internet users with the consumer-protection they deserve, while providing content and web-site developers with a clear set of rules that can be successfully and accountably implemented. A similar approach has been adopted by the US clinicians' professional organization, the American Medical Association. The AMA 'Guidelines for medical and health-information sites on the Internet' are intended to remove barriers to the transition towards shared decision-making between patient and physician. They cover the same issues as those mentioned above, with some additional comments on e-commerce, and they wisely recognise the pace of changing technology by acknowledging that the guidelines will need continuous revision.

5.2.3. Ethics and Legality of Internet Based Medical Services: To date, the use of the Internet to deliver medical services has been largely restricted to advice in a patient-carer setting or to the dispensing of prescriptions. In the former situation, the value of the online therapy to the patient is clearly dependent on the credentials and expertise of the carer.

Even if the qualifications and status of the clinician are above question, (and these may be difficult to assess) it does not follow that this person can exploit the new medium to offer the care that he or she would provide in a traditional consultation. There are also many opportunities for misunderstanding, due to the absence of visual clues and the tendency for the mind to fill in knowledge gaps in an idealistic way.

These problems point to the need for some sort of accreditation with training and assessment guidelines. King and Poulos address these issues from the standpoint of clinical psychologists and raise concerns about the use of email (therapy) to counsel patients and the need for a better understanding of the medium and its constraints.

Although we have suggested that the impersonal nature of computing and the Internet can raise ethical problems, there are circumstances, particularly in psychiatric and psychological conditions, where the interpolation of a machine between patient and carer can be less threatening to the patient, who may feel less self-conscious and able to exercise greater control over events. These circumstances can be exploited by the skilled practitioner but the skills must be acquired and the education and licensing of qualified therapists must be part of any ethical system using the Internet.

When we turn to prescribing, we find that 1 October 2000 is a watershed in the use of the Internet for dispensing drugs. This was the day that the Electronic Signatures in Global and National Commerce Act became law in the USA. While the law does not require private individuals to use or accept electronic signatures as authorisation, it gives such signatures legal enforceability when they are so used. The 'E-sign' law, as it has become known, requires the presence of an interstate or foreign transaction. Prescribing is clearly a transaction and, in modern times, the international nature of the pharmaceutical industry almost guarantees the second requirement. Thus, prescriptions signed with electronic signatures are legal documents for the supply of medication, just as handwritten prescriptions on paper.

E-sign allows state agencies to specify standards for the accuracy, integrity and access to records, but prevents them from substantial regulation of transactions and the reimposition of paper-record requirements. E-sign has consequently been regarded by some US states as an assault on their rights and the law has created considerable tension. Furthermore, there is no requirement that the electronic signature bear any relationship to the signer: an 'X' is perfectly acceptable. The law seems certain to make lawyers richer.

5.3 Other Issues and Challenges

5.3.1. Improving User-Acceptance of Health-Care Telematics: Tele-health represents a new approach to health-care, with the potential for improving accessibility and reducing costs. Over the years, technology has become increasingly interactive, cheaper and standardized. Despite this, the uptake of technology has been low. One of the main reasons is that the introduction of telematics in health-care requires more than technology and software----organizational and cultural change is required, as well. A suggested approach is based on the principals of service-quality and high-quality management, to produce a partnership between the users and developers of new technologies. This will, in turn, make it possible to bring user-validated requirements into the design of the system and create feelings of ownership and motivation on the part of users, in order to prepare their environment for the change. This methodology has been effectively used in various projects of the Telematics Application Program of the European Commission.

5.3.2. *Managing the 'Fit' of Information and Communications Technology in Community-Healthcare:* The 'fit' of information and communication-technologies (ICT) in community health is important in meeting the needs of patients, carers, staff and organizations in the delivery of services. A good fit leads to greater efficiencies and effectiveness in use of ICT. There is a need to look not only at the role of ICT, but also at how to manage ICT and make a good ICT fit so as to enhance community health-services. Tele-health was identified as the application of ICT to enhance population-health, health promotion and delivery of health-service. A participatory process is critical to determining needs and potential uses, as well as to the successful design and implementation of ICT in health. There would be an additional value in ensuring a diversity of desired outcomes, which can balance costs and benefits while fostering capacity and technical sustainability.

5.3.3. *Preparing Doctors & Surgeons for the 21st Century - Implications of Advanced Technologies:* An entire spectrum of advanced technologies and concepts has been presented, from the new clinical applications to highly speculative possibilities. Not all of these technologies will survive the long process to clinical usefulness, but those that do may well revolutionize surgery and other medical procedures. With such change comes the ethical and moral responsibility to consider them not only in the light of improvement of patient-care, but also in their impact on society as a whole. Fundamental changes in the organization, financing, and delivery of health-care have added new stress-factors or opportunities to the medical profession. These new potential stress-factors are in addition to previously recognized external and internal ones. The rapid deployment of new information-technologies will also change the role of the physician towards being more of an advisor and provider of information. Many of the minor health-problems will increasingly be managed by patients themselves and by non-physician professionals and practitioners of complementary medicine. If the remarkable rate-of-change of the past 2 decades continues, it is almost impossible to conceive of the future precise role of surgeons / doctors. Thus, to be prepared, surgeons/doctors must have an open mind, a willingness to consider and evaluate new directions, and the honesty and courage to change when a new approach is proven to be of value. A prepared mind is an open mind.

5.3.4 *Library Outreach:* Addressing the "Digital Divide": A "Digital Divide" in information and technological literacy exists today between small hospitals and clinics, in rural areas, and the larger health-care institutions in the major urban areas of the world. Some efforts have been made to address solutions to this disparity; one of them is the outreach-program of the Spencer S. Eccles Health-Sciences Library at the University of Utah, in partnership with the National Network of Libraries of Medicine-- Midcontinental Region, the Utah Department of Health, and the Utah Area Health-Education Centers. In a circuit-rider approach, an outreach librarian offers classes and demonstrations throughout the state that teach skills of information-access to health-professionals. Provision of traditional library-services to unaffiliated health-professionals is integrated into the library's daily workload, as a component of the outreach program.

5.3.5 *Managing Changes in Informatics – The Organizational Perspective:* The successful introduction of information-systems into any healthcare organization whether a primary care physician's office, or a complex health care organization-requires an effective blend of good technical and good organizational skills. A system that is technically excellent may prove woefully inadequate if people resist its implementation. The person who knows how to manage the organizational impacts and stresses of new information-systems can significantly reduce behavioral resistance to change—and resistance to new technology in particular—to achieve a more rapid and productive introduction of those systems.

5.3.6 *Patient e-Care – Addressing the Concerns of the Providers:* Online patient-care or patient "e-care" could revolutionize the centuries-old paradigm of medical practice. Patient e-care can bring back the "house call" experience, long-missed by consumers, and could potentially allow healthcare to become proactive rather than reactive. Moreover, patient-monitoring and interactive management data can be fed directly into patient's electronic medical records. Consumers/patients embrace the concept of e-care. Providers, however, tend to be threatened by a change of the medical practice paradigm and by the (perceived) impingment upon providers' hectic time-schedules. Most providers felt that they did not have enough time in their busy schedules (i) to learn the new technology required, (ii) review daily patient-data, or (iii) interact with their patients online.

Providers expressed a need for solutions that offer better patient-care but would also not require more time from the providers. Technical e-care solutions must address both patient-wants and provider-concerns. Solutions that save time for providers, while still offering the advantages of patient e-care, must be found. For example, Internet software that automatically monitors and even manages some aspects of a patient's condition, while keeping the provider informed, appears to be one solution.

5.3.7 *e-Content: the Challenge of Providing Authentic & Quality Health- Information:* Health information is amongst the most frequently accessed informations on the web. Accordingly, the breadth of health-information offered on the web is vast. However, a new public-health concern is the extremely variable quality of health-related information on the Internet, ranging all the way from reliable, evidence-based information, to fraudulent, commercially motivated, unbalanced or misleading information. For patients and consumers, and even for health-professionals, it is often difficult to judge the trustworthiness of digital information.

6. CASE STUDIES

6.1 Dakota Telemedicine System, Bismarck, North Dakota*

The case study is on the project of Telehealth services that Medcenter One Health-Systems provides in rural areas of North Dakota, USA. Medcenter One Health-Systems is a large integrated tertiary-care facility located in Bismarck, North Dakota. Medcenter One provides the full range of medical care, from emergency medicine and trauma to surgery and chronic care. Organizationally, the telemedicine program falls into the outreach arm of Medcenter One, and was recently reorganized under the aegis of Physician Support Services, Medcenter One developed the Dakota Telemedicine System (DTS) in 1995, connecting community-hospitals in Linton, Wishek, and Bowman to Bismarck (as the hub). At the time of application, the DTS had already handled more than 250 specialty consultations.

A. Background

Community Characteristics: The state of North Dakota is one of the most rural in the USA. The majority (59 percent) of the population lives in communities of less than 10,000 people. Access to healthcare for North Dakotans outside of urban areas is poor. Forty-three of the 53 counties in the state have been designated either partial or full health-professional shortage areas. The state also has a large number of older adults (14.3 percent in the state, 12.6 percent nationally). High levels of poverty also mark the state: 13.8 percent live below poverty-line, and 36.4 percent live at less than twice the poverty- line income. North Dakota and surrounding states have high concentrations of veterans: 43 percent of the veterans are over age 65, and 7 percent are disabled. Despite the high need for health-care, there is only a single Veterans Administration (VA) facility, located on the eastern border of the state in Fargo. Providing access to quality-care in local communities is thus a high priority for medical facilities in the state, given how dispersed the population is and how difficult travel can be in the northern plains during winter months, together with the shortage of medical professionals in the state.

B. Project Overview

Problems/Disparities that the Project Was Designed to Address: Due to the degree of isolation between rural, outlying communities and larger towns and cities, access to high-quality, specialty medical care is limited. Prior to the introduction of telemedicine, patients needing specialty- care would need to be treated at one of a small number of large hospitals, possibly hundreds of miles from their homes. Similarly, once treated, they would have to travel the same distances to conduct follow-up visits with a specialist. Because of the time and inconvenience associated with such isolation, many patients avoided medical care or follow-up. For example, according to the project-proposal, nationwide, veterans living within 5 miles of a VA hospital were

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* Snow, K. 1999, Dakota Telemedicine System Bismarck, North Dakota, N.T.I.A.

more than twice as likely to utilize its facilities for acute medical and surgical care than were veterans living more than 5 miles away (3.4 percent versus 1.5 percent). The introduction of telemedicine allows general practice doctors at rural clinics or hospitals to consult with specialists hundreds of miles away, frequently avoiding the need to transfer patients to the larger, more distant facilities for initial or follow-up care.

Anticipated Outcomes

There were a number of anticipated outcomes listed by the project director. These included:

- Increase access to care. The project expected that there would be an increase in the number of patients seen by physicians in remote sites, and by specialists, through consultation at Medcenter One.
- Improve Alter-referral patterns, so that more patients are treated locally. The project expected that the number of referrals to out-of-area medical facilities would decline during the project.
- Improve the quality of care at remote facilities. This was linked with decreasing the number of referrals; providing care on site, rather than out- of-area, was one sign of improved quality.
- Impact treatment through consultations between primary providers and specialists. Primary-care doctor consultation with a specialist was expected to impact the number of initial diagnoses that were changed. The expectation was that specialists would help to provide more definitive diagnoses than initially given.
- Increase-patient satisfaction with care. Patients were expected to view experiences with telemedicine favorably, us comparable to their expectations of telemedicine and consistent with their ideas about quality-care.

C. Community Involvement

Community Outreach

- Involving Community Stakeholders: From the beginning of the project, efforts have been made to involve state and national government leaders. The project-director has been very active in soliciting and obtaining the support of local and national political figures. Medcenter One has a strong community-presence, through its outreach programs. These programs include Parish Nurse, a program connecting nurses to local churches, and Medcenter One Foundation, a program sponsored by Medcenter One to raise funds through local businesses to provide medical care and equipment. Currently, there is no particular emphasis on involving community stakeholders with telemedicine specifically, although the director plans more active community-involvement in the future.
- Needs Assessment and Feasibility Study: Prior to beginning telemedicine services in 1995, Medcenter One spent nearly 3 years in research and development. This

research used data from state and national census to document the need for more available medical care, especially among veterans and members of outlying areas (see Community Characteristics, above). Additionally, because Medcenter One already had relationships with most of the rural facilities in the project, both sides were aware of the needs and capabilities of the other. The remote sites and Medcenter One worked together to develop the plans for implementing telemedicine in the system. From its inception, a core of doctors was invested in developing the telemedicine system. Once the organization had made a commitment to telemedicine, some feasibility-testing of possible system-configurations began; for example, early on, the project compared the performance of two videoconferencing systems before selecting one as the appropriate technology. The project director pointed out that the feasibility-testing of the technology was at least as much about generating physician buy-in as they were about testing the equipment. During the early feasibility- testing, the equipment was used for demonstrations in efforts to recruit more doctors as potential end-users of the system once it was in place.

- Project Outreach: Prior to the beginning of the project, care-providers at each of the project-locations (including Medcenter One and the Fargo VA hospital) received information about telemedicine and were invited to participate in a demonstration of the system. Initially, the community was informed about the Telemedicine project through news media stories, including newspaper and television interviews. In general, patients would be told about the project only if their condition warranted the use of the system. When the care-provider felt that there was need for further consultation (cases he or she would otherwise refer to the hospital in Bismarck), the patient would be told about telemedicine and would be given the option of using the system. In emergency consultations; the patient may or may not have known about telemedicine prior to its use. Most of the additional outreach from the project was filtered through the local clinics/hospitals. For example, the continuing education teleconferences (e.g., surgical grand rounds), special education programs, and diabetes-support groups were all advertised using fliers in the sites. Project staff felt confident that potential end-users knew about telemedicine in their communities, especially if they used the local clinics for care.
- Training: One of the unique features of this project is that key project-personnel acknowledged little technical training or background. Typically, this is a substantial liability. In this project, however, it was not, for several reasons. First, the technology most encountered by the users (physicians and patients) is videoconferencing equipment, which offers an extremely easy interface. Second, at each site a particular person has been identified as the telemedicine coordinator. This person typically handles all of the details of the technology for the site, easing the need for all people, on site, to be trained. Third, the people with most contact with the underlying technology were either trained by the local electronic vendor (who also provides technical assistance) or learned by doing. These key people on the project had knowledge of what the system was capable of and how to solve most problems, even if they individually lacked specific, highly

technical knowledge. It was clear that the technical aspects of the project were well managed.

- Protecting Privacy: Issues of security and privacy seemed of little concern to the project. The Dakota Telemedicine System is entirely closed. It comprises dedicated lines connecting sites via a bridge at the hub location. There is no interface between the system and the Internet, and the only way into the system is to be connected to the hub, which occurs either at an appointed time (as for consultations) or following a phone call for assistance (for emergency consultations). These calls, as well as fax transmissions, all occur over dedicated telephone lines, again enhancing security. At each location, the telemedicine equipment is located in areas that allow for privacy, typically small conference rooms or other spaces. While this physical arrangement allows for privacy, the system is designed to be portable and may be moved to more or less private settings, as needed. Additionally, at least one doctor noted that the previous system, involving faxing patient-information from site to site, was no more secure than the current system, and the advantages of the telemedicine system far outweigh any privacy or confidentiality concerns that he would have.

Patients who use telemedicine in this project do sign a consent form. Among other things, this consent form acknowledges that they are being treated through telemedicine and gives the project permission to videotape all activity on the system. These tapes are then catalogued by project-staff and kept for later reference, as needed (either by the physicians on the case or to confirm quality of care). Currently this consent to participate and be videotaped falls under one disclaimer, but project-staff acknowledged that a patient consenting to telemedicine but not videotaping would receive care and not be videotaped.

D. Problems Encountered

Lack of Telecommunications Infrastructure in North Dakota: The project was originally designed while a single telephone company provided all line-service in the state. After the grant was awarded and the state telecommunications industry was deregulated, a larger number of local companies took over service in many areas. While the project had been designed with the capabilities of a single provider in mind, now the project had to cope with a number of companies using different products with varying levels of technical expertise. This caused delays, either in installing lines or in maintaining the lines once installed. Additionally, different companies were using different types of lines that need to be integrated prior to accessing the bridge at the hub site. To deal with this problem, the project- director advised each provider what the necessary technology was, even if the provider had not yet worked with it. Second, the electronics-vendor served as the system-integrator. Although integrating a number of different network-technologies caused some delay, the project director said that having an integrator in place, who could accommodate a range of technologies, was actually a benefit in the long run. Now the system is accessible to new connections, even if the networks are not the same as those already in place.

System Is Not as Fully Utilized as Designed: The technical aspects of this project are such that it can accommodate more remote sites (based upon the number of available ports in the network- bridge) and more users (due to the number of available channels). To this point, the project staff has been somewhat disappointed that the system has not been used as much as it could be. Project staff and participants feel that, as more physicians try the system, more will use it. The project-director also noted that physicians at remote sites and project-staff at Medcenter One had a number of ideas about expanding the scope of services provided via the system, but the staff is currently too small to actualize many of these ideas.

Physical Constraints: As previously described, in each site the telemedicine equipment is located in a specific location. In some sites this is centrally located and provides ample space for physicians and patients, or small groups for specific programming. In others, the room is quite small, or is also a conference room needed at other times for meetings. Doctors at one site suggested that if the equipment were nearer to the emergency room, then they would likely use it more, while doctors in another site suggested that if the equipment were located in a larger room, they would be able to use it more for patients. One potential solution, a roll-about unit, was requested by one site but then later exchanged for the larger system used by the other sites, because the video- images were too small. Most sites have not suffered due to the space constraints, though it is clear that the location of the equipment varies from site to site, largely based upon where space is available rather than where the unit can be most conveniently located.

E. Project Outcomes

Impact on End-Users: In the Dakota Telemedicine System, patients and doctors both received benefits as end-users. Specifically, because consultations were typically arranged to occur between primary-care physicians and specialists, with the patient present, the physicians were end-users and the patients were secondary beneficiaries. In other instances, patients made appointments for follow-up consultations or other appointments with specialists. In these cases, specialists and patients were both end-users.

Impact on Patients: Overall, about 5 percent of the patients served by Medcenter One are seen via telemedicine, either through direct consultation with specialists or through consultations with specialists arranged by primary-care physicians. In cases of direct consultation, patients were the end-users. This was particularly the case for patients receiving mental health-care or follow-up therapies. After each telemedicine consultation, the patient would complete a satisfaction survey. These have been overwhelmingly positive among patients receiving direct consultations with their specialists at other sites. Many patients respond with open comments about the ready availability of seeing their doctor over telemedicine versus having to travel great distances for what are typically very short follow-up visits. Patients were especially comfortable seeing a specialist via telemedicine, if they had previously seen that specialist in person at least once.

While it is clear that many of the patients seen through telemedicine are saving a great deal of time and expense by staying in the local community to receive care, the impact on the quality of the care relies more upon physician and patient satisfaction. From the data collected via patient- satisfaction surveys and onsite-interviews with doctors, it is clear that both groups are generally satisfied with telemedicine. The project also tracks any impact that consultations have on initial diagnoses (number of changes in diagnosis after consultation). These numbers, too, suggest an effective impact of telemedicine on the patients, as some diagnoses are altered following consultation with the specialists. Additionally, the number of referrals to Medcenter One from remote clinics has declined over the course of the project, suggesting that patients are now able to receive prompt, appropriate care in their local facilities. In 1998, only 6 percent of patients seen via telemedicine were transferred and treated outside of their own communities.

Impact on Physicians: Most typically, the end-users of the Telemedicine project were the physicians, both primary care and specialists. In 1998, the most recent year for which data were available, 33 individual doctors, plus doctors at the VA hospital, used the telemedicine system for consultations, though they varied in how frequently they consulted. One doctor in a remote clinic accounted for 17 percent of the consultations, and one specialist at Medcenter One accounted for 16 percent. Most of the doctors using the service, however, had fewer than 10 consultations in the year. There were also substantial differences in system-use by area of specialization. Nephrology (17 percent), mental health (16 percent), and dermatology (13 percent) were the three most common specialty consultations.

Most of the doctors reported that using the telemedicine system was advantageous to their delivery of services, though most also pointed out that there are particular cases where the system is especially suited for use and others where it is not. Several doctors made it clear that being situated next to a patient, regardless of the patient's need, was preferable to seeing the patient over telemedicine, but often the choice is between telemedicine and not seeing the patient at all. All thought that the system allowed them to have more contact with more patients, both through telemedicine and in person, because it allowed them to work more efficiently. In some cases, telemedicine allowed specialists to provide care for a small number of patients at a remote site, without leaving the hospital, allowing the doctor to save time otherwise spent traveling between sites.

Doctors in the remote sites also benefited from the system by expanding their medical skills, if only in a somewhat limited way. For example, when the primary-care doctor sits in on a consultation between a diabetic patient and the specialist at Medcenter One, the doctor learns about new therapies and research that he or she might not otherwise know about. Additionally, at least one doctor noted that having the telemedicine system available, even if he does not use it for a number of days, is a security blanket. He knows that if he needs help in treating a patient, there is a specialist available for consultation. This doctor also noted that this availability provides a sense of "team" that doctors at small rural sites often do not have.

Impact on Other End-Users: Two unanticipated types of end-users have emerged, as the project expanded in scope. One group of 12 students is completing coursework in interpretive sign-language as part of a certification program. This is a program that would not otherwise exist, so the completion of the program itself is an important outcome for these students. Another student completed a supervised social work internship through the project. Again, she could not have met her course-requirements without the project.

Impact on Other Beneficiaries: The larger community also stands to benefit from the Dakota Telemedicine System, though demonstrating this is more difficult. However, several of the physicians, and the project-director all noted the impact on the community. They saw the provision of high-quality, specialized care as an instrument in building the economic base of a community. As they expressed it, people and companies are reluctant to locate to a community that lacks quality- schools and medical care. Telemedicine allows the rural clinics to provide quality-care, in the community, thereby retaining people in the community who would otherwise leave.

F. Lessons Learnt and Recommendations for Other Communities

Having an Integrated Medical Center at the Core of a Telemedicine System Is Essential
The project manager felt that, because Medcenter One is a fully integrated medical system, able to respond to nearly all medical needs, it was in a better position to serve as the hub of the telemedicine project. This is in contrast to a number of telemedicine systems that provide specialty care in a small number of medical areas only (e.g., a system linking hospitals to cope with early neonatal apnea and other forms of distress). Because the goal of the project was to enhance all medical care for patients in outlying areas, having the ability to provide a range of care is essential to the project's legitimacy.

Know the Technology: The project director made it clear that understanding what technology was needed to do the job was essential, especially in a state with relative poor infrastructure (both materials and skills). She was often in a position of working with service-providers who knew less about the technology than she did. This put a high premium on the project's ability to determine what technology was needed.

Keep the System Simple, Reliable, and Flexible: Partly because the project operated in an environment with a developing infrastructure, there was a high premium on developing a system that was not more complex than it needed to be. The project's choice of easy-to-use videoconferencing equipment was partially the result of this mentality. The simplicity of the system, which makes it possible for nearly anyone to learn how to use the equipment, greatly increases the number of possible end- users by removing technology-barriers to access. Also, the simplicity of the system adds to its reliability. With a simple, direct system, the number of possible problems is greatly reduced, and when problems do occur, they tend to be easier to locate in simple systems. Additionally, the project has invested in technology that allows for the growth of the project. For example, the bridge in place at the hub-site is perhaps the most critical piece of technology in the system, and it has room for expansion, as needed (i.e., as more remote sites come online). Finally, although the project has a focus on telemedicine, the fact that videoconferencing is the mode of delivery has not been lost, as the project takes advantage of the videoconferencing equipment in ways not directly related to telemedicine (e.g., the interpretative sign language class).

Putting in the Work Ahead of Time Pays Long-Term Dividends: The project spent 2 years in research and development before any implementation began. This time was valuable because it allowed the project to test the feasibility of multiple systems, as well as develop plans for how the system would be used. Not only did this allow the project to avoid "reinventing the wheel," but it also created a relationship between the project and end-users that contributed to their buy-in of the project. Indeed, the field-testing of alternative videoconferencing systems played a large role in communicating to the physicians that the system was there for them, and their opinions about how it would work were important.

Communicating with End-Users is a Two-Way Street: In this project, communication between the project at the hub-site and end- users in remote sites flows in both directions. The project encourages sites to raise both problems with the system and ideas about what services to provide via the system. Medcenter One does not dictate what services are offered, but is responsive to the needs and desires of users at the remote sites. The project also involves the remote sites in marketing and research activities. For example, many sites have played roles in Medcenter One's marketing of the project, participating in videoconferencing demonstrations to funders and community groups. Likewise, Medcenter One provides remote sites with data about use as well as feedback about patient-satisfaction. The project- director points out that, by listening to the project partners, the project avoids building features or services that the end-users would not use, and is also able to call on the end-users to identify which service-models work and so do not need to be recreated.

Know What Data to Collect and How to Use Them: Telemedicine sites, by necessity, collect data. Gathering data about a patient's medical and family history, monitoring which services he or she receives for the purpose of billing, and arranging visits with medical professional are all requirements of a medical delivery-system. So, the project has a large set of data that it must collect. Keeping everyone informed about the procedures to manage all of this data may be a difficult task, but the project-director sees clear advantages. First, by developing a standard reporting system, the quality of the data is higher. The reliability is also higher if there is a set standard. In this project, there were site manuals providing all of this information. The data-collection approach taken by Dakota Telemedicine related directly to its approach to communication among project-partners: everyone is informed. The data-collection system is being further developed by the site, as it pursues electronic patient-records, in this current phase in its approach to data-collection.

Existing Procedures Must Work with New Technical Approaches: As previously outlined, there are a number of steps that must be taken between the time a patient arrives at a remote site and is determined as a potential telemedicine patient, and the time that the patient is seen by a specialist who has all of the patient's medical records and information. The system currently in place, at Medcenter One to take all of these steps, is not fundamentally different from what steps would be taken to see the patient as a referral from the remote site prior to telemedicine. That is, phone calls are made, appointments made, records faxed or mailed, etc. Although seemingly ponderous, because this information-exchange occurs in the same way as before, it is actually quite efficient. The project, however, is aware that the system can be made more efficient, and is pursuing electronic patient records as one means of doing so.

G. Summary and Conclusions

The Dakota Telemedicine system is a very successful program. It is a powerful application of technology to a critical problem in the state. The number of awards it has received from numerous agencies reflects the high value placed on it by others. In this section, some of the potential reasons for the program's success are presented. These reasons may be instructive for other communities facing a similar need and/or considering the development of a telemedicine system to serve those in the community.

The Site Staff Knew It Was Needed and Would Be Used: Medcenter One was providing integrated medical care for patients throughout the state, either through its main hospital in Bismarck or through its affiliated rural clinics, long before developing the Dakota Telemedicine system. The hospital staff knew the needs of its patients, and from a history of working with physicians in the field knew how to work with their care-providers. The assessment of needs performed by Medcenter One confirmed what they already knew about the need for care in rural areas. The support for the system came from both doctors at the hub-site as well as doctors in the clinics. Indeed, the development of the project has been through an exchange of ideas between remote sites and Medcenter One.

Telemedicine, Though Revolutionary, Was Not a Paradigm Shift: Telemedicine was seen as an extension of how medical care may be provided. As noted above, Medcenter One and its affiliated doctors viewed telemedicine as an extra option in treating patients. It was not seen as a replacement for doctors or rural clinics, rather as an extension of their ability to serve patients in their own communities. Further, several doctors noted that telemedicine's usefulness only extended so far, and that not all patients could benefit from it. In short, telemedicine did not fundamentally shift the way doctors saw themselves or how they performed, but allowed them to perform more efficiently or more effectively. To them it was a natural extension of medical practice that allowed them to better serve some patients.

The Right Combination of Factors Includes Personnel, Technology-Choices, and Support: The telemedicine project is exceptional, in part, because it succeeded where there would otherwise be so many reasons to struggle. The project- director came to the project with little technical expertise. The telecommunications infrastructure in the state was minimal, both physically and in terms of knowledgeable personnel. Videoconferencing is still not very widely used. Despite these factors, the project-director developed the expertise with the help of the equipment vendors, the physical infrastructure was gradually brought on-line, and the technology is being used without much trepidation. These factors seemed to have jelled around three critical, related decisions.

First, the choice of uncomplicated videoconferencing equipment made the technology accessible to anyone with a minimum of technical skill. The most complicated aspects of the system are the mechanisms that control the bridge for the network, and much of its design and implementation was done by the vendor who then provided technical assistance to members of the project staff who were willing to learn. Second, the choice of videoconference equipment was made by those who would be using it—the doctors. This, together with the role played by physicians in the development of services for the system, created a sense of common purpose. Decisions about the system are made with input from physicians and patients. The decision to involve physicians in planning for the system virtually guaranteed the presence of end-users.

Finally, the selection of project personnel and staff-development brought the pieces together. The project-director is an energetic and enthusiastic advocate for the project. The fact that she has acquired the technical knowledge to run the project allows her to relate to those without the technical skills. Using site-coordinators at each location relieves the technical and day-to-day activity strain from the physicians, creating a situation where all that is required is their willingness to use the equipment. Finally, doctors using the system are not directed to use it, but rather see the system as valuable for their own reasons. Because of this, physicians are free to use the system on their terms, or not at all. Thus, if a doctor does not agree that telemedicine is valuable (as is the case with some at Medcenter One), that doctor does not use the system. Doctors using the system, however, become strong advocates and powerful partners in the system's development.

6.2 Northern New Mexico Rural-Telemedicine Project, Espanola, New Mexico*

The project is being administered by the Northern New Mexico Community College in Espanola. The college's primary mission is to prepare the residents of northern New Mexico for employment. Besides many other things, the college supports a variety of community outreach projects throughout the northern region of the state.

The college's primary role on the project was to oversee all aspects of the grant. This

* Silvestein, G. 1999, Northern Mexico Rural Telemedicine Project, Espanola - New Mexico, N.T.I.A

has included assuring that the schedule and budget are being met, facilitating communication among the projects' various partners and stakeholders, preparing proposals for additional funding, working with Internet service-providers and telephone-companies to establish a telecommunications infrastructure, and attending conferences to learn about related activities and to publicize the telemedicine project. The college has also been responsible for obtaining and providing technical assistance to individual sites. Examples of technical assistance that have been provided to individual sites include ordering equipment, deploying and configuring computers and printers, establishing e-mail accounts, and providing training to clinic staff.

A. Background

Community Characteristics

The Northern New Mexico Rural Telemedicine Project is being conducted in the following counties in northern New Mexico: Colfax, Guadalupe, Harding, Los Alamos, Mora, Rio Arriba, San Miguel, Santa Fe, and Taos. The combined population of these nine countries is 222,601 (1990 census). The population density for this region is 27.4 persons per square mile. However, the population density drops to 4.2 persons per square mile when the cities of Los Alamos and Santa Fe are excluded. According to the 1990 Census, 59.6 percent of the residents in these nine counties are Hispanic, 35.9 percent are white (non-Hispanic), and 3.2 percent are Native American (15.2 percent of the residents in Rio Arriba County are Native American).

Approximately one-fifth of families in the project's service area—and one-third of families in two of the nine counties—are living below the poverty level. The service area has no public transit system, a limited manufacturing base, and a small private land base from which to develop an economy. According to a document developed by the Northern New Mexico Community College, 54 percent of the land in Rio Arriba and Taos Counties is owned by the state or federal government, while 17 percent is owned by eight Northern Native American Pueblo Tribes. This leaves these two counties with only 28 percent of their land- base from which to develop an economy and generate tax-revenues for services. As such, employment opportunities in the region can be scarce. For example, a Walmart that opened in January 1999 received 2,500 applications for 450 positions. One-third of these hires were part-time employees with no benefits.

B Project Overview

Problems/Disparities the Project Was Designed to Address

The project was designed to help rural health-providers and patients overcome the barriers associated with the remote locations of the region's clinics and hospitals. These barriers include: the significant distances that many patients must travel to receive medical care, the distance between rural clinics and larger hospitals that have specialized staff and equipment (in six of the nine counties, clinics are located 30 to 40 miles from the nearest hospital or major medical center), the inability of patients to confer with specialists at remote sites, the lack of a systematic method for sharing medical records across clinics and hospitals, medical providers' limited capital for infrastructure improvements, the difficulty of providing continuing professional development to rural health-care professionals, and the fear that rural practitioners will choose to relocate to urban facilities that offer access to the most recent medical technologies. The project intent was to lower some of these barriers by enhancing medical providers' capacity to access and share patient information.

One of the primary objectives of the Northern New Mexico Rural Telemedicine Project was to facilitate communication among clinics that share common patients. During the site-visit, project staff provided examples of instances in which patients might rely on several clinics to receive treatment, including:

- Patients in isolated regions may need to visit another medical provider (e.g., a hospital in Espanola or Los Alamos) for specialized tests or treatments.
- An individual seeking confidential consultation or treatment (e.g., when obtaining birth-control advice, taking a pregnancy-test, being tested or treated for a sexually transmitted disease, being counseled for substance abuse problems) may travel to a clinic or hospital in another town—especially if the receptionist in the local clinic is on a first-name basis with the patient's immediate family or friends.
- Patients may travel to several clinics in a region to obtain and abuse multiple orders of prescription medications.
- Patients may have to travel to a neighboring medical facility if the nearest clinic is closed (some rural clinics are not open 5 days per week).
- A patient's preferred medical provider may be at a different clinic on a given day.
- Patients may travel to another clinic to obtain a second opinion.

In each of these cases, a patient's failure to bring his/her medical records could potentially result in treatment that is incomplete, duplicative, or harmful.

C. Anticipated Outcomes

The proposal to TIIAP delineated three primary outcomes:

i. A decrease in the number of instances where patients arrive without referral information,
ii. a decrease in the number of patient-records that are lost, and
iii. a decrease in the number of patients with multiple—and conflicting—medical records.

During the site visit, project staff articulated a number of other potential outcomes:

- A reduction in the number of duplicate prescriptions.
- A reduction in the number of instances in which patients experience an adverse reaction to a drug that was prescribed (these reactions are more likely to occur if

physicians lack accurate information on other medications that patients are already taking).

- Increased patient satisfaction, e.g., resulting from a reduction in duplicate tests being performed by multiple medical providers.
- The ability to retain medical staff in isolated rural areas. Specifically, project-staff felt that rural physicians concerned about a lack of career- opportunities would be eager to participate in a project that was on the cutting edge of medical technology.
- The ability to increase the community college's capacity to prepare students for careers in technical fields. In addition, staff at LANL viewed the project as an opportunity to identify students who might someday work at the lab.
- An increase in the time that physicians and other medical staff would be able to devote to face-to-face contact with clients.
- An increase in the spirit of cooperation among the region's medical providers. According to one respondent, "the very act of sharing information serves to encourage collaborative partnerships."
- The development of powerful and enduring partnerships among the region's medical providers. Several respondents indicated that one of their primary goals was to build partnerships with other organizations in the region that could potentially facilitate their patients' access to quality health-care.
- The institutionalization of a mechanism by which individual patient- information could be aggregated to a higher level in order to satisfy institutional, state, and federal reporting mechanisms.

D. Project Status at the Time of the Site-Visit

At the time of the site visit, the project was operating under an extension from TIIAP through September 1999. Because of extensive delays associated with getting individual clinics connected to the information infrastructure, the TeleMed application was not actually being used in any of the clinic sites. Plans were underway to use the TeleMed software in order to share information across the three clinics that compose the Las Clinicas del Norte health-care system. This test, scheduled to occur during the summer of 1999, will be limited to the sharing of immunization data. Once this function has been tested, staff at Las Clinicas del Norte would like to place all of their medical records on-line and take full advantage of the TeleMed system.

Project staff was unsure as to whether the other medical providers would deploy the TeleMed system before the TIIAP grant has expired. At the time of the site-visit, a number of the clinics affiliated with the Health Centers of Northern New Mexico had yet to be wired (and were therefore not in a position to share data outside of their building). As is discussed later, the high costs associated with connecting rural sites to the Internet may preclude some of these 14 clinics from ever deploying the TeleMed system. In addition, while the two participating hospitals were in a position to use the system to share data internally (e.g., between the emergency room and an onsite pharmacy), they will likely wait until after the immunization function has been tested by Las Clinicas del Norte.

Even after the system has been successfully deployed, a series of confidentiality policies need to be adopted before patient data can be electronically transmitted between two unaffiliated medical providers. (Clinics that operate under the same provider-system, such as Las Clinicas del Norte, would be able to share electronic files since they operate under the same confidentiality policies and procedures.)

Project Outreach: The project used several methods to inform prospective end-users about the TeleMed systems. Staff from the clinics and hospitals were active participants in the design and development of the project. These staff members eventually took a lead role in promoting the benefits of the TeleMed system to their colleagues. In addition, as described previously, a series of focus-groups were conducted at the beginning of the project. These focus-groups were used to provide background information about the project and solicit end-users' input as to the types of functions they would like the system to perform.

As the project progressed, the end-users received training in how to use their new personal computers to access the Internet. Project staff hoped that providing physicians with Internet access (e.g., for conducting online medical research, communicating electronically with colleagues) would enhance their understanding of TeleMed's potential and, ultimately, foster their buy-in for the project. However, buy-in among end-users became a problem as the project progressed. Project staff indicated that this was due to two factors. First, physicians were not particularly excited about the limited functions (e.g., patient immunization history) that were to be deployed during the project's test phase. Second, project staff indicated that their early assurances about the system were diluted by the subsequent delays in providing Internet access and implementing TeleMed at the clinical sites. After a while, the ongoing delays led physicians to question whether the system would ever be deployed. In hindsight, project staff indicated that the bulk of their outreach efforts should have been postponed until after the infrastructure was in place and the system was ready to be shared with end-users.

Training: Staff at the community college was responsible for developing training manuals and providing system-related instruction to the end-users. The initial training, conducted with clerical staff, after the personal computers were installed at the clinic sites, was held at the community college over several weekends. These sessions were designed to introduce end-users to the Internet, e-mail, Netscape, word processing, Access, and Excel. According to project staff, some trainees required instruction in such basic skills as using keyboards, while others were already experienced Internet users (as is discussed in Section C, a needs-assessment was used to identify the skill-levels and training needs of prospective end-users).

By the time of the site-visit, the individuals who had been conducting training and providing system-support had left the community college. In the short term, this has not presented a problem since the clinic sites have staff, on site, who can address immediate training-needs. However, once TeleMed is deployed, physicians and clerical staff will require additional training in how to access and use the system. LANL staff indicated that they expect to assume responsibility for providing TeleMed training. Once the system is ready, LANL staff hopes to train a pool of end-users who, in turn, will tutor their colleagues.

Protecting Privacy: The TeleMed system is designed to provide physicians with a secure method of sharing personal and medical information with other providers. Project staff pointed out that TeleMed represents a substantial improvement over current methods used to share patient-data (in the words of one respondent, "how do you fax a 50-100 page document?"). For example, when faxing medical data, there is always a concern that (1) sensitive information will be intercepted by staff that is not authorized to view patient medical records, (2) a misdialed phone number will result in sensitive information being faxed to a private residence, and (3) the length of the document to be faxed will result in lost pages and incomplete information being passed on to a physician.

The TeleMed system overcomes these problems by assuring (1) authentication, i.e., users are who they say they are, (2) authorization, i.e., users are allowed to do what they ask to do, and (3) confidentiality, i.e., the requested data are given only to authenticated, authorized users. In addition, in an effort to ease providers' fears about system-integrity, the initial deployment of TeleMed will only involve the electronic transfer of immunization data (which are not considered to pose a security or liability threat). Project staff suggested that successful deployment of the immunization module would alleviate providers' concerns about the use of the Internet to transmit medical data.

During the initial focus-group sessions, clerical staff and medical practitioners raised a number of concerns about using the Internet to transmit patient-data. For example, participants expressed concern about who would have access to the medical records and how access would be controlled, with some suggesting that patients should have some (or total) control over who has access to their medical history.

At the time of the site-visit, project staff was struggling to develop a process by which patients could grant permission to have their medical data shared electronically with other providers. Several barriers were cited as complicating this task.

First, project staff underestimated the amount of time required to develop a patient-consent form that would satisfy the concerns of multiple stakeholders. This happened, in part, because staff was planning to modify forms being used to obtain patient-consent in another Internet-based system. However, as it turned out, these forms were being used to approve data-transfers within a single medical- provider system—and therefore did not address issues associated with sharing data across two or more medical provider systems.

Second, participating clinics need to delineate the specific items in a virtual patient-record that a given individual should be able to access. For example, clerical staff might be permitted to access a patient's address and billing information, a nurse might be able to access a patient's medication schedule, and a physician might be able to access all data within a patient's medical record. These "rules" can then be incorporated into the TeleMed system; e.g., an end user's identification code would automatically enable or restrict access to a given data item. This process becomes complicated when providers have different rules regarding levels of access; e.g., in clinic A, nurses are only permitted to view a patient's medication history, while clinic B permits nurses to access all information within a patient's medical record. These differences will need to be resolved and incorporated into the TeleMed system before any patient-data can be shared electronically across distinct medical provider systems.

E. Problems Encountered

The Northern New Mexico Rural Telemedicine Project experienced a number of problems that delayed the deployment of the TeleMed system. At the time of the site visit, it was unclear whether these problems would ultimately affect the project's ability to achieve all of the objectives delineated in the original proposal to TIIAP.

Difficulty in Obtaining Matching Funds: At the beginning of the project, a number of partners—including several telephone companies—withdrew their support for the project. According to project staff, technical specialists in one corporation were prepared to lend substantial financial support ($250,000) to what they envisioned would be a "global physician network." However, this support was ultimately terminated when corporate staff decided that there was no long-term cash benefit to wiring such a rural region, that is, there would not be enough other users outside of the medical community to make the system financially viable.

The quarterly report concludes that one overriding problem with the TIIAP match requirement is that there is "no penalty for corporations…who commit to a large match and then simply pull out of the process, leaving the non-profit community partnership holding the bag."

In the short-term, the loss of corporate support required the project to devote valuable staff-resources to identifying alternative sources of funding. In the long term, it delayed the hiring of a project director (since the community college lacked the resources to hire additional staff until federal funding for the project had been authorized) and contributed to extensive delays in connecting participating clinics to the information- infrastructure. (As is discussed later, project staff concluded that, in hindsight, it would have been better if they had received a planning grant. This would have enabled them to (1) solidify their financial base, (2) assess the status of the region's telecommunications infrastructure, and (3) identify phone companies that were willing to take on the task of connecting the participating clinics and hospitals.)

Delays Due to Difficulties Gaining Line Connections: A second factor that caused a significant delay in the deployment of TeleMed was the lack of a telecommunications infrastructure in northern New Mexico. This problem was compounded by a number of interrelated factors. First, several small, independent telephone companies provided service to the region. As a result, a single health-care provider network with many clinic sites might have to negotiate with multiple providers to secure connections for all of its sites. In addition, the lack of a single provider meant that some health-care providers had to engage in complicated technical arrangements to gain Internet service. Also, participating clinics risked incurring additional costs, associated with providing Internet services across two phone-systems (one respondent cited a $1,000 per month expense to cover a 12-inch gap where the wires for one phone company system ended and another began). Second, phone companies were generally unwilling to provide cost-effective Internet services to a region that was viewed as lacking other potential users (e.g., businesses, households). Third, rates for several of the small, independent phone companies fluctuated over time, leaving participating clinics concerned that their costs might unexpectedly increase in any given month. As a result of this issue, staff at the Health Centers of Northern New Mexico indicated, during the site-visit, that they were reluctant to network their most rural clinics.

Lack of Support by College Administrators: At the time of the site-visit, the grant recipient had decided to withdraw from the project at the end of the TIIAP grant period. This decision reflected the belief of top-level administrators at the Northern New Mexico Community College that the role of their institution was to initiate and facilitate—but not sustain—efforts to bring telemedicine to the region's health-care providers. Once a process for implementing such a system had been established, the administrators did not believe that the community-college should assume ongoing responsibility for the telemedicine initiative.

The project's partners were disappointed—but not surprised—by the community college's decision to discontinue its participation in the telemedicine initiative (several respondents pointed out that the TIIAP proposal had been prepared under the direction of a previous college president). Respondents were equally disappointed that specific segments within the community college were not more supportive of the project during the TIIAP grant period. Several respondents indicated that they would have expected the faculty to be especially interested in being part of an initiative that was on the cutting edge of computer technology. Further, they would have expected the community college to use the project as a means of creating potential learning and employment opportunities for computer-science students.

Staff Turnover: By the time of the site-visit, most of the individuals who had conceived of and supported the telemedicine project had left the community college (most of these individuals left for higher paying jobs). This included the original college president, who had encouraged the development of the TIIAP proposal, the individual who had prepared the TIIAP proposal, and the two staff members who had provided training and technical support to the clinics. Respondents indicated that as the project progressed, the departure of these staff placed additional pressure on LANL to provide clinics with training and technical support.

Delays Due to Developing a Patient-Confidentiality Policy: At the time of the site-visit, the online capacity to share patient data across unaffiliated health-care providers had been delayed until all participating hospitals and clinics could develop common confidentiality policies and procedures. Several barriers were cited as complicating this task, including (1) the amount of time required to develop a patient- consent form that would satisfy the concerns of multiple stakeholders and, (2) differing levels of access to confidential patient-data across unaffiliated providers.

Project staff was confident that once the participating health-care providers had developed appropriate procedures, the technology would be sufficient to safeguard patient data. They did note, however, that this issue might need to be revisited each time a new provider was added to the system. Nonetheless, project staff indicated that; once they had resolved this issue, the resulting consent forms would be of use to other telemedicine projects that seek to link unaffiliated providers.

F. Project Outcomes

Impact on End-Users: As discussed previously, the TeleMed software had not been deployed in any of the clinics at the time of the site-visit. It is therefore not possible to describe the system's impact on medical practitioners in northern New Mexico. Project staff was, however, able to describe the benefits of providing health-care providers and record-keepers with personal computers and access to the Internet. Prior to the TIIAP project, clinics were not equipped with personal computers. Internal record-keeping was done on paper, and communication among clinics was primarily accomplished via long-distance telephone conversations. While the clinics received personal computers early in the project, they did not receive modems and access to the Internet until 1998-9 Project staff indicated that clinic staff primarily used their personal computers for word- processing. Some staff also learned how to use the database support packages. Once they received Internet access, medical providers and clerical staff began making considerable use of e-mail to communicate with colleagues in other sites, to avoid the high cost of phone-calls between the clinics and between clinics and the nearest hospital. In addition, providers in these clinics have been using the Internet to conduct research and access national medical databases.

Impact on Other Beneficiaries: According to project staff, residents in some isolated communities have begun using the clinics' personal computers to become familiar with the Internet. One respondent pointed out that in much of northern New Mexico, health-clinics represented the only workplace where workers had integrated personal computers into their daily routines. Citing the importance of maximizing the clinic's role in the community, he provided numerous examples of how youth (and other residents) have been provided with opportunities to learn about and use computers. (This emphasis on providing computer-access to youth was considered especially important, since the local schools are not connected to the Internet.) For example, Las Clinicas del Norte has trained several high- school students to purchase computer-components on the Internet and build and fix computers. Learning these new skills improved the students' self-esteem and provided them with a highly marketable skill, especially given the shortage of computer specialists in the project's service area.

Project staff also indicated that their collective efforts forced the development of a telecommunications infrastructure in many of the area's more isolated regions. They predicted that this, in turn, would ultimately benefit other businesses and individuals that wanted economical and reliable access to the Internet.

G. Lessons Learnt and Recommendations for Other Communities

Project staff identified a series of lessons that they learned as a result of their efforts to introduce telemedicine to health-care providers in northern New Mexico. While some of these lessons are specific to telemedicine projects, others pertain to any human service agency that is interested in using "virtual client records" to facilitate information sharing among multiple personnel who interact with—and document the services provided to—a single individual.

Set Aside Sufficient Time to Assess the End-User's Telecommunications Infrastructure: Prior to applying for TIIAP funding, project staff indicated that they had a comprehensive understanding of the need that their project was designed to address. However, some of the individuals interviewed during the site-visit indicated that, in hindsight, they should have also assessed the feasibility of implementing their proposed approach—in the proposed timeframe—in some of the state's most rural regions. Such a feasibility study could have been used to (1) document the steps that would need to be taken to connect participating clinics and hospitals to the information-infrastructure, (2) more fully assess the willingness of the region's telecommunications providers to extend Internet-access to participating health-care providers, and (3) identify the full range of barriers that would need to be overcome before the TeleMed system could be deployed. While many of these issues were addressed during the initiative, project staff indicated that it would have been useful to have had this information in hand at the time the TIIAP proposal was submitted.

Project staff therefore recommended that communities should attempt to address these issues before submitting a proposal to TIIAP. As an alternative, they suggested that projects include a 6- to 12-month planning phase in their implementation-schedule that can be used to align partners' expectations, work with telephone companies and other providers to assess the telecommunications capabilities of prospective end-users, identify a realistic process and timetable for enhancing end-users' telecommunications capabilities, assess whether there are any alternative approaches that might be easier to implement, and collect baseline data that can eventually be used to assess the project's impact.

Convene Stakeholder Meetings on a Regular Basis: Project staff suggested that a valuable lesson from their planning-process is that all relevant partners and stakeholders should begin meeting on a regular basis, as early in the process as possible. (In the words of one respondent, "technology is a piece of cake—the hard part is working with people.") Respondents also noted that by convening at the same time (e.g., the last Friday of every month), participants will be more likely to consider these meetings a permanent fixture on their calendar.

The Northern New Mexico Rural Telemedicine Project demonstrated the value of involving stakeholders and end-users in all key-decisions. From the beginning, partners and prospective end-users were provided ample opportunity—through monthly meetings and focus groups—to describe what they hoped to gain from the telemedicine project. The mechanisms used to solicit stakeholder-input served to promote long-term buy-in for the system (especially among project partners). This long-term buy-in to the project's ultimate "vision" was especially critical, given the extensive delays that hindered the timely deployment of TeleMed. It will be interesting to track the project's future progress to determine whether the use of monthly meetings and focus groups ultimately results in a system that meets the needs of the region's health-care providers and medical record keepers.

Do Not Raise the Expectations of End-Users Prematurely: If expectations continually exceed reality, end-users will lose faith in the system before it has even been implemented. From the very beginning, physicians and other end-users were asked to offer feedback on what the telemedicine project should be designed to accomplish. Unfortunately, delays associated with the clinics' poor telecommunications infrastructure have led some end-users to lose interest and faith in the project. According to one respondent, "It will be hard to reengage the medical providers in the final product. They have already started to bad-mouth the project." In hindsight, project staff indicated that they should not have promoted TeleMed to health-care providers until they actually had a system that was closer to being operational.

Begin with a Small, Manageable Component of the Overall Project: Project staff stressed the importance of providing partners and end-users with a series of small victories, along the way, to keep participants motivated, focused, and "hopeful." Since, the initial deployment of TeleMed is occurring in only three clinics (as opposed to all of the participating clinics and hospitals), project staff will have an opportunity to focus their energies on a manageable cluster of end-users. The lessons learned from this trial run will enable the project-team to make any necessary adjustments, before deploying the system to all of the participating clinics and hospitals.

Provide End-Users with the Necessary Technical Skills: As the initiative progresses, there is a growing risk that LANL staff will be required to play a greater role in providing clinics with technical support and training. Given the size of the territory to be covered, project staff recognizes that this is not a practical long-term solution. As such, they recommended that future telemedicine initiatives take steps to train a pool of clinic/hospital staff who can serve as trainers and technical trouble-shooters.

Include Stakeholders in the Process of Selecting the Project-Director: The community college was not in a position to hire a project-director until after the TIIAP grant had been awarded. In spite of their role in the rest of the initiative, none of the partners was asked to participate in the process of (1) determining the qualifications for, and role of the project director, (2) interviewing prospective candidates, or (3) making the final selection. While partners understood the community college's position—in the words of one respondent, "Who wants to give up that kind of control?"; they also suggested that their input would have helped them feel more vested in their new leader. (It should be noted that the project-director expressed similar concerns with the process by which he was selected).

Several respondents (including the project director) also suggested that future telemedicine initiatives select a director with at least some medical knowledge. They indicated that selecting a project director who is familiar with both computers and the health-care industry would facilitate ongoing outreach efforts among medical and technical staff.

H. Summary and Conclusions

Although only partially implemented, the Northern New Mexico Rural Telemedicine Project has already had an enormous impact in the rural regions of northern New Mexico. Specifically, it has laid the groundwork for the deployment of a telemedicine network, introduced e-mail and the Internet to a growing number of medical end-users, helped to forge a long-term alliance between LANL and the region's health-care providers, and served as a model for a potential statewide immunization database.

From a national perspective, the project serves as a model on several fronts. First, it suggests a process for using meetings and focus-groups to garner community-support and involve partners and end-users in the decision-making process. Second, it provides an effective model for collecting data that can be used to evaluate the impact of technology in the workplace. Third, it represents one of the nation's first efforts to develop forms and procedures that can be used to transmit patient-data electronically across unaffiliated medical providers.

7. TELEMEDICINE IN DEVELOPING COUNTRIES

7.1 Introduction

Many developing countries have inadequate health-care and medical services and they also suffer from a shortage of doctors and other health-care professionals. The inadequate infrastructures of telecommunications, roads and transport make it even more difficult to provide health-care in remote and rural areas. Where clinics and hospitals exist, they are often ill-equipped and, especially outside urban areas, beyond the reach of normal communications.

Developing countries face various problems in the provision of medical service and health-care, including funds, expertise, resources, which relate to the lack of facilities and systems. Roads and transportation are inadequate and problems are often encountered in properly moving or transporting patients.

For countries with limited medical expertise and resources, telecommunications can provide a solution to some of these problems. Telecommunications may help alleviate some of the shortages. Telemedicine services have the potential to improve both the quality of, and access to health-care, regardless of geography. They enable medical and health-care expertise to be accessed by under served locations. Telemedicine offers an effective mean to quickly improve the delivery of health-care and medical service. It can help in emergencies from natural disasters, combating tropical diseases and meeting the particular requirements of dermatology, traumatology and many other specialities of medicine.

In the developed countries, there has been a rapidly growing interest in telemedicine and tele-health as a mean to ease the pressure of health- care on national budgets. It may well be that some of the technologies and experiences of the developed countries could be of help to developing countries in their desire to provide, especially, primary health- care.

Telemedicine and tele-health have many socio-economic benefits, can generate new sources of revenues for service-providers and equipment- suppliers and can optimize the use of available human and capital resources in developing countries. Applications, such as telemedicine and tele-health, should be of interest to telecom-operators since they generate additional traffic over existing networks and offer the opportunity to extend limited networks. The telecom and health "industries" can thus achieve synergies.

At the same time, telemedicine needs to be well managed and implemented carefully. The impact of telemedicine on health-care structures can be significant. It also raises concerns about legality, liability, confidentiality, competition and other policy and regulatory issues.

In this chapter, an overview of the use of telemedicine in developing countries has been given which involves several breakthrough as well as difficulties.

7.2 Breakthroughs Provided by Telemedicine in the Developing Countries

There is no doubt that telemedicine has the potential to improve the quality of health-care. Telemedicine might evolve as a cost-effective alternative to some forms of health-care delivery. However, among others, the economic, organizational, legal and ethical aspects have to be taken into account. A thoroughly performed cost/benefit evaluation will certainly be of crucial importance for health-care policy-makers when deciding if telemedicine should be generally introduced or not.

The delivery of telemedicine services yields many socio-economic benefits, including those derived from national development objectives such as the following:

Cost Savings: Telemedicine could help some countries to cut health-care costs. A substantial part of the cost of running hospitals is spent on what are essentially hotel services: bed, breakfast, lunch and evening meals.

Although Telemedicine costs today are not low, yet countries with high health-care costs are interested in the prospect of telemedicine as a way to reduce costs and demands upon hospitals. The more health-care can become decentralized and administered efficiently in low-cost settings, such as clinics with telecommunications links, the less dependent patients become on expensive, asset-based sites, such as hospitals, for specialty care.

Reduced Waiting Lists: Telemedicine could reduce hospital waiting-lists if patients can be seen more quickly by using telecom-systems; with the consequent reduction in hospital waiting lists, it can allow treatment to be given immediately.

Reduced Travel: Some of those who use telemedicine can avoid the need to travel to far-away doctors and hospitals. It can save patients time and money by eliminating the need for a trip to the hospital.

Telemedicine enables health-care professionals to consult quickly with specialists many miles away, without the cost and risk of transporting an ill or injured patient long distances, perhaps over rough terrain.

Other then that, telemedicine can provide access to centres of excellence for various specialities -- theoretically from anywhere in the world. Telemedicine allows the scarce resources of specialists and expensive equipment to be shared by a much greater number of patients. Doctors are no longer restricted by geographical boundaries; international specialists are able to spread their skills across continents, even to battlefields, without ever leaving their own hospitals.

Universal Service: Those who have had no or limited access to medical care, especially in remote and rural areas, can take advantage of telemedicine services if they have or can use a telephone (and, better still, other telemedicine equipment too).

Stress Reduction: Families are spared the stress and expense of visiting relatives who have had to go for treatment to a hospital in a distant city.

Training and Education: It can help in medical education and training. For those health-care professionals working in rural areas of developing countries, access to remote medical databases on the Internet, for example, could be a boon for keeping up-to-date with what is happening in their field, to share experiences and address questions to other doctors.

Telemedicine can be an important source of case-study material from every part of the world. Students in one place can watch an operation being performed by a surgeon or physician in another place. If telemedicine continues to grow, specialists will be able to track an increase in the incidence of a particular disease, as it happens. It is not always possible to get students to attend or watch live operations, so the next best thing is to record the operations and play them back. This also allows the lecturer to stop the tape and explain further or even to do an "action replay". When the money is available, there is no reason at all why students shouldn't be able to watch live operations being conducted anywhere in the world and communicate directly with the surgeon.

Revenues: The provision of telemedicine and tele-health-care services offers the possibility of making the most of tight health-care budgets, but also offers revenue-generation and employment opportunities. Telemedicine is a high-tech industry, comprising equipment-manufacturers and service- providers, who generate revenues from the sales of their products and services. Telecom networks can generate additional revenues, if their networks are used for the provision of telemedicine and tele-health.

Employment Opportunities: Telemedicine can also be helpful in providing employment opportunities to indigenous technicians and paramedics.

Betterment of Rural Areas: Availability of regular or on-demand health-care in remote areas helps slow down migration of population and attract people back to previously abandoned areas. It also helps in attracting required personnel (including but not limited to medical practitioners) to remote and rural areas, with a positive impact on the local and national economies.

7.3 Difficulties in Setting Up Tele-Health in Developing Countries

The developing world has had relatively little experience or success with telemedicine. This is, in part, because of the high costs associated with Internet connectivity, high-end videoconferencing systems and sophisticated peripheral medical devices. Expensive technologies are simply out of the reach of health-organizations in developing countries, which may have more immediate priorities (such as providing nutrition, sanitation and vaccinations to the population). To make things worse, developing countries have very high patients-per-doctor ratios, which are a general indicator of the amount of healthcare or lack thereof that exists in a region. As a point of comparison, industrialized countries such as the US have one doctor for every 200 to 500 people, while developing countries in East Africa have as little as one doctor for every 40,000 people. The state of health of a population is a direct determinant of its development, and investment in health is a prerequisite to economic and social progress. Developing countries need low-cost, sustainable solutions for the local delivery of primary healthcare and efficient access to medical expertise, when needed.

In addition to all the normal barriers to tele-health, developing countries potentially have a number of unique difficulties, such as:

7.3.1 The Gap between Need & Demand

The Developing world consists of countries where individuals are receiving the benefits of organ-transplants and genetically engineered drug- therapies, while the brain-development and health of millions of children are languishing due to a state of malnutrition. Space technology-enabled telecommunications could allow people of the third-world countries to technically provide medical information, on demand, to anywhere on the globe. Yet, 70% to 80% of the population of the world does not utilize allopathic medicine as we know it today. These are only a few of the great diversity of challenges that the developing world faces in improving the tele-health infrastructures, globally, where need for and the ability to demand life-sustaining and health-enhancing services often exist as worlds apart.

7.3.2 Infrastructural Inadequacy

The lack of access to the infrastructure needed to support all levels of tele-health applications is the primary systemic-barrier to the widespread introduction of these services in to the rural and remote communities of developing countries. The inadequacy of the infrastructure includes the following:

- The majority of rural and remote health-providers in developing countries do not have access to telecommunications infrastructure that will support anything other than basic exchange of electronic information, such as e-mail. Technology-infrastructure to enable the provision of tele-health clinical services requires, in general, high bandwidth communications facilities, which are at present expensive to install or make available to end-users, and for the end users to connect with and to use.
- Lack of money to purchase the technology or telecommunications
- Limited number of people who know how to operate, install or repair the technology or telecommunications
- Limited access to parts for repair
- Limited access to electricity
- Unstable electrical supply

- Limited or unreliable power supply
- Health-care system that may be poorly organized
- Health-care system that may be poorly funded
- Limited number of health-professionals
- Number of other pressing clinical health-care needs

7.3.3 Lack of Government-Support

Most of the governments in developing countries have limitations and so do the private enterprises. Any technology especially in its primary stage, needs care and support. Only the government has the resources and the power to help it survive and grow. But most of the third-world countries are not the favored ones. Mostly, no such initiatives are taken by the government to develop telemedicine.

7.3.4 Perception of Doctors

Doctors are not fully convinced and familiar with telemedicine in the developing countries. They cannot understand how their jobs can be performed more effectively and efficiently through the use of this technology. The very thought of diagnosing a patient when he/she is physically absent, just on basis of the data provided through the net, turns them blue.

7.3.5 Patients' Fear and Unfamiliarity

There is a lack of confidence in patients, about the outcome of telemedicine, due to lack of education in the third-world countries. The main problem is that any treatment consists of two factors; first is chemotherapy i.e. treatment by medicines and the other is psychotherapy that means treatment by emotions, which is absent in e-medicine.

7.3.6 Confidentiality and Security

The confidentiality of medical records is the biggest barrier to the full realization of telemedicine. Instantaneous access, though extremely beneficial, requires the use of large medical record databases, which contain information about all patients cared for by a particular hospital. But if large databases of medical records are ever left unprotected, those confidential records become jeopardized. This factor can be problematic for the people living in the third-world countries, specially the female patients.

For that matter, private industry suppliers of tele-health systems must become familiar with the principles which various organizations are adopting with reference to protection of privacy and be able to ensure adherence to standards which will protect user-privacy and confidentiality of transactions.

7.3.7 Licensure and Accreditation

Telemedicine creates conflicts between states, or countries, over the rules and regulations of accreditation and licensure. Medical licenses are issued by states, and therefore it becomes illegal to practice medicine in any other state, since rules for accreditation may differ between them.

8. DEVELOPING AND DELIVERING THE SERVICE OF TELEMEDICINE

8.1 Describing Service-Objectives

The profile of telemedicine and tele-health has risen with healthcare providers, policy makers and commercial enterprises, due to both technological and non-technological factors. These agencies are better placed to design, plan and implement mainstream telemedicine services with enhanced awareness of the technical and service options. (Essentials of Telemedicine and Tele-care by A.C. Norris, Department of Management Sciences and Information Systems, University of Auckland – New Zealand)

The initial stage is to describe the service objectives. It is imperative to decide what the project is trying to achieve and whether telemedicine is the suitable way to deliver the objectives or not. It is also a fact that telemedicine is more like a technological 'honey-pot', catching the attention of participants who are intrigued by the uniqueness and reputation-making nature of remote techniques. But self-deception is also a risk in such situations and it is unethical to support a proposal simply because the technology looks catchy.

It is also essential to carry out a meaningful analysis to determine the real purpose for a project. The reasons for going ahead might still be motivated by political priorities, but they must involve healthcare professionals and potential users and be clinically sound. Telemedicine is likely to be a strong option when the major service-objectives are:

- Better quality of care;
- Extended access to care;
- Minimizing the cost;
- More collaboration and integration;
- Creating educational opportunities.

The proposals of telemedicine most likely to succeed will fulfill most of these objectives. An important feature in these discussions is the nature and degree of the present services. For example, a prime candidate for tele-medical support is a service that is routinely referred out of district or region, most commonly due to the lack of the trained personnel. If, following this qualitative analysis, telemedicine looks as if it is the appropriate technology for the project, then it becomes necessary to quantify the needs of the target population. Only then can we decide if the service can meet these needs and be sustainable within the imposed constraints.

8.2 The Evaluation of Needs

For simplicity, we can confine ourselves to three types of need — clinical, economic and technical — and consider each of these in turn. Further information on assessment of needs is provided by Doolittle and Cook.

8.2.1 Clinical Needs

Clinical needs can be described in many ways, but the criteria given below are especially pertinent:

- *Specialty's Nature:* The specialties in which external, visual examination is required to be carried out are well suited to telemedicine. If the patient's condition lends itself to such examination then telemedicine may well meet the clinical need. Otherwise an internal examination or surgical intervention, then more conventional, face-to-face methods may be carried out. Telemedicine may still meet part of the clinical need.
- *Purpose of Service:* The main purpose of the service, which can be communication between physicians or the diagnosis, monitoring or treatment of patients, effects the needs, design and cost. For example, a diagnostic cancer service will have fewer resource-demands than one that offers treatment involving chemotherapy. This will be especially so if the remote curer is unfamiliar with the treatment and uncomfortable with providing the service at a distance from the specialist.
- *Human Resources and Training:* Considering the previous point, fulfilling a clinical need may require additional personnel or a training- requirement, especially at the remote site if healthcare professionals are not familiar with the equipment and its technicalities. These demands may inflict unacceptable expenditures on the project, which, if they cannot be met, may shatter its scope or cause it to be stopped, since it would be unsafe to carry on.
- *Service Incorporation:* When keeping in view clinical need it may be possible to use telemedicine to carry out the integration of services. Thus, a minor injuries centre could transmit X-rays to a physiotherapist working in a primary-care practice, or a GP could share case-notes on a psychiatric patient with a social-care worker. These extensions comprise 'added value' and do not have to be too costly.

8.2.2 Economic Needs

We can in the same way describe a few simple criteria for the assessment of economic needs. All of these criteria are influenced by the volume of tele-consultations. Estimates of the levels for each type of activity are essential to the assessment of costs and income.

- *Stan:* The staff of a new telemedicine service may be new appointments or personnel recruited from existing staff. Either way, there is a cost implication, which must be factored into the assessment of economic needs. Other than the appointment of doctors, specialists and nurses, the non-clinical requirements should also be considered. The non-clinical requirements will include technicians to support the running and development of the service, and possibly clerical staff and office managers. Again, costs can decrease if existing staff are willing to undergo career-enhancing training and take up new roles, particularly if additional remuneration is on offer.

- *Capital and Revenue Costs:* Capital costs are usually associated with tele-consultation equipment, network-infrastructure and facilities such as buildings. They are definitely important in the initial phase, but will reoccur if and when the service is upgraded, especially if the revised service demands greater bandwidth. There is a great need to devise strategies regarding the apportionment of these costs between the various participants, for example between a hub and its remote sites. These strategies can be made on purely economic grounds, e.g. a remote centre may incur line-costs if it makes extensive use of a network-connection or have these costs offset if it brings in a significant number or reimbursable referrals to the specialist centre. Other than that, costs can be divided up in accordance with some policy-formula if the project is sponsored by a grant or charitable foundation.
- *Income and Reimbursement:* The distribution of earned income should be addressed at the needs-assessment or design stage since any delay can lead to friction, which can nullify the benefits of the service. Each situation varies, as the previous criterion on costs demonstrates, and it is essential to include all principals in the decisions. Physician reimbursement is a different issue and negotiation with funding agencies or insurers may be necessary to determine the economic viability of the service.
- *Restructuring Costs:* Telemedicine services can cause considerable disturbance for carers, not least if they reduce or replace existing services. If the service is based on a hub and several remote centres, the departmental reorganization at the hub is the most common trouble, with significant cost-implications. Costs may also be incurred by relocation of other services, to group telemedicine staff and equipment together, and streamline delivery.
- *Patient-incurred Costs:* Patients may incur additional costs, such as travel, time off work and child-care, and these should be included in the evaluation.

8.2.3 Technical Needs

Criteria for the evaluation of technical needs involve technology audit, network infrastructure, and user needs.

- *Technology Audit:* The technology audit identifies not only the equipment that should be bought to run the service but, since these requirements are often modest, existing equipment, e.g. videoconferencing systems, which can be pressed into service. The kind of equipment needed will depend on the nature of the service. For instance, a desktop unit is suitable for many clinical purposes but a roll-about system is better for videoconferencing or medical education where group-interaction is required. Some patient-conditions will also require specialized tele-monitoring equipment, which may have limited use outside the tele-medical service. All equipment should be simple for non-technical people to understand and use.

- *Network Infrastructure:* The network infrastructure may be owned and under the control of the telemedicine team but it is more likely to be leased from and maintained by a telecommunications provider. In this situation, it is contain that a cost-overhead will incur that cannot be ignored. In addition, a viable service will create a demand for higher bandwidths and the technical requirement may translate into an economic one. Flexible bandwidth-configuration is highly desirable, as are alliances to share infrastructure and costs.
- *User needs:* New technology can be intimidating to both patients and carers, and it is essential to evaluate their needs, so that they feel at ease with the equipment and procedures. This requirement may have a cost-implication but it is unlikely to be high and well worth paying to ensure acceptance and satisfaction with the service. In the same way, regular users may have preferences for the type of equipment that is specified, e.g. the distinction between roll-about and desktop-systems noted above. Or technicians may like a certain type of equipment because it is simpler to maintain. These and related issues should be evaluated by involving users, patients and suppliers in the specification of requirements and in the buying decisions.

8.3 User Involvement

It is obvious from what we have said already that user-involvement is an important constituent of telemedicine development and users include both carers and patients. These are the front-line people who will largely decide the success or failure of the service. Their skill and experience is fundamental to ensure that the service is not only goal-driven but rewarding to use.

It is also important to have the loyalty of senior clinicians and managers, who should be evident supporters of the project at all times, even if they are not directly involved in detail developments. Let us build upon our needs-evaluation to sum up some of the more vital aspects of user- involvement.

- *Involve Remote Sites:* In the excitement and rush of planning it is natural to develop a centralist approach and underestimate the importance of users at the remote sites. These users, both carers and patients, should be involved in the design and operation of their site.
- *Manage User-Expectations:* The hopes of users are essential, not only in designing a service, but in monitoring and making it better. Users with lesser experience of healthcare delivery, let alone telemedicine, are often intimidated by procedures that carers may find trivial, and patients can readily be made comfortable by simple explanations of what is going to happen to them and what the results and timeframes would probably be. Longstanding patients switching from traditional to tele-medical treatment come with certain expectations that condition their acceptance of the new technology, and learning from these experiences is a powerful way to deliver best practice.
- *Build Teams:* The service will be more viable if the individuals identified in the needs-evaluation process see themselves as members of a team. Clinicians, nurses,

technicians and administrators (and patients) may well have different ideas on the development and operation of the link, and team-building is the necessary process of combining these multidisciplinary outlooks into a coherent approach. Acknowledging the validity of other people's ideas and efforts (publicly, wherever possible) are essential to this process. The approach of a team at a remote site can vary from one at the central location. Reconciling these different behaviors may be an added challenge.

- *Ensure Training:* There will be a major requirement for technical and clinical-related training among the team-members. A plan for initial and ongoing training is required for the prosperity of both staff and patients. It may well be useful to involve selected patients in this plan, since they can act as major advocates of the service.
- *Locate Services:* The needs-evaluation stage will identify priorities, in terms of clinical need, and planners may be tempted to site link-points within areas of highest concern. However, clinical needs must be balanced against economic and technical requirements and it is useful to locate link-points where user-involvement and expertise are highest.
- *Integrate Services:* Needs-evaluation and team-building may identify opportunities for service incorporation, for example, using a telemedicine link to make possible patient-monitoring in a community after a tele-consultation or a discharge from hospital. Another, more motivating, option might be a disease-management programme.
- Cross-Discipline User-Involvement is the key to integrated service development, and planners should be proactive in harnessing these opportunities.
- *Market Services:* External marketing is essential to ensure the take-up and growth of the service. Furthermore, internal information-sharing among healthcare colleagues, via seminars, workshops and evaluations, is also necessary to promote the service. Also, it may be useful in encouraging past and future patients to participate in these ventures.

8.4 The Business Planning

Although these are continuing exercises, needs-evaluation and user- involvement are important components of the business-case, to seek funding for a telemedicine project and for devising its implementation. What else goes into the case depends upon the domestic situations and what the planners learn during these procedures. However, based on our discussion so far, we can identify certain core elements that should appear in every case. Clyburn presents a highly detailed analysis of the business-case for telemedicine in terms of business process reengineering, change-management and organizational culture. Although interesting, the pragmatic approach adopted here is more relevant to most practitioners, viz.

- Define the real objectives: As we have seen, 'pseudo' objectives are sometimes offered in order to give trustworthiness to a project-case which is really nothing more than a bid for funding techno-enthusiasts to experiment with technology.

This is unluckily most common with academic grant submissions. The results of such awards may solve useful problems but not necessarily those for which the grant was awarded. To win support and reliability in the telemedicine world, the project must involve one or more of the service-goals to which we can add efficiency and revenue-generation. The business case should narrate whether the proposal is a pilot or a full production project.

- Finalize population and demand: For telemedicine to enter mainstream medicine, it must be sustainable by a critical mass of tele-consultations and/ or other activities (e.g. medical education). The business case is therefore more likely to work if it can demonstrate (realistic) benefits to a large section of the public or to some vulnerable section of it, e.g. children. A project may also catch attention if it addresses often terminal conditions, such as cancer, multiple sclerosis or HIV/AIDS, that have no routinely effective cure. Eventually, a case may be funded for political as well as clinical reasons if it reduces a significant deficiency in service-provision.
- Establish a link with existing services: We touched this point in our discussion of needs-evaluation. A mainstream role for telemedicine will only come about if the approach can merge with vital existing services. Where there is conflict with existing services, the business-case should describe the impact of the new telemedicine system, how it might make some services (and staff, particularly consultants) redundant and extend others. Everyone can be a winner if the case can show savings in facilities and the release of personnel who can be employed in other understaffed areas of the organization. Finally, it is essential to keep in mind that the probability of success, both in winning support and achieving objectives, is more certain if the project deals with telemedicine services that have been successful elsewhere.
- Sum Up technical options: The business-case is no place to rehearse detailed technical arguments. However, since the case must state the financial implications, it is wise to describe technical choices in the broadest terms, so that those evaluating the case recognise that they are getting value for money. Value for money might equate to low cost, but ‘fitness for purpose’ is a more convincing argument. Both the business case and the subsequent planning should demonstrate how the service will use the equipment and network to its full capacity, if not straight away at least over a defined period. Projects that specify expensive technology and then underuse it are unlikely to receive continued support. The business case should also plan for the future, and flexibility and expandability often carry their own cost. Evaluators will recognise the merit of paying the extra, if the arguments are clearly put.
- Explain the benefits: This is an important component of the business- case, elaborating on the service goals. The case should also bring into light the added-value components implicit in the service-goals. For instance, patients could be directed to Internet resources and support- groups for their condition, or a tele-cardiology service could be linked to “wellness programmes” for healthy diet and exercise.
- Consider collaborations: As recommended in the discussion on technical needs,

alliances with other organizations are useful for sharing expensive resources, such as medical equipment and network infrastructure. Where the partners have complementary skills and facilities, such an alliance can extend the services beyond what either could offer and thus gain a competitive edge or unique selling-point. However advantageous technically, some alliances may be politically sensitive and these are best avoided, at least in the business case.

- Specify market opportunities: The removal of the distance-limitation on care-delivery opens up several possibilities for the more entrepreneurial minded clinician or health-services manager. Examples include:
    - opportunities for consultants to use telemedicine to practise abroad;
    - use of civil telemedicine facilities by military organizations;
    - health-support contracts with transport organizations, e.g. airlines,
    - opportunities for telemedicine consultancy and education;
    - opportunities for private sector referrals or new fee-based convenience shipping;
    - Services.
- Project management: The business case should show how the project to plan and implement the service will be managed. A good project- management methodology, such as PRINCE, is a critical requirement, given the diverse cultures of the participants and their geographical distribution. PRINCE offers particular benefits via its focus on results and the provision for rigorous risk-assessment and contingency plans. For a start-up project, the business-case should request funding for an experienced, full-time project-manager who can drive the project and ensure that the service is introduced on time, on budget, and to the required (and expected) quality levels.

8.5 Business-Process Reengineering

Business-process reengineering (BPR) implies an attempt to break down an organization's business-practices into their component parts and reassemble them to form a new machine. Traditional, large organizations operate on the 'Adam Smith principle' (The Wealth of Nations, 1776), by which "economies of scale" are obtained by training groups of workers to contribute specialist skills efficiently to the manufacture of products or delivery of services.

BPR challenges this dictum. It uses information-technology as a catalyst to reengineer, so that a smaller number of non-specialists can handle the whole process. It examines the whole organization, or that part of it under scrutiny, to see which processes are essential, which can be improved, and which can be cut out without real loss. Planning, execution and control, decision-making, workflow and reporting; all are taken apart and reassembled, making IT an integral part of the new operation. Telemedicine is a new way (process) to deliver medical care and it relies heavily on information-technology. It follows that the introduction of telemedicine into a healthcare organization should give many opportunities for BPR to increase quality and efficiency, and lower cost. Interestingly, there are very few reports of its application to telemedicine, largely due, perhaps, to the cultural differences between healthcare and the business world.

Given the potential of both BPR and telemedicine, this is a pity, as the only substantial article relating the two topics demonstrates. In contrast, here are just a few examples by which reengineering of conventional care, through telemedicine, can bring benefits:

- Reduction in travel for patients;
- Closer collaboration of clinicians in primary and secondary care;
- Availability of international medical expertise in real time;
- Improved clinical and administrative workflow;
- Seamless integration of care-services across sectors;
- Use of tele-medical monitoring devices in the home.

These examples reveal that, in practice, the introduction of telemedicine nearly always involves BPR, although it is often as a consequence of 'introducing telemedicine' rather than a proactive attempt to discover opportunities for streamlining services and increasing efficiency. A more proactive BPR approach could pay considerable dividends.

8.6 Selecting the Technology

Technology underpins the successful delivery of telemedicine but it is not an end in itself. The main technology consists of a telemedicine system, e.g. videoconferencing stations, display systems, tele-monitoring devices, telecommunication options, etc., and relates them to the applications and clinical procedures for which they are appropriate. Acquaintance with the content of this chapter will help a service-planner to answer most of the essential queries or refer them to experts and suppliers. For convenience, we simply list some of the technology issues associated with the design and development of telemedicine systems:

- the bandwidth required to deliver the essential service efficiently;
- the network infrastructure and its installation and repair;
- suitability of hardware and software for store-and-forward or real-conformance of equipment with accepted standards;
- the choice of videoconferencing station, e.g. rollabout, desktop, etc.;
- the display definition and colour depth of the display;
- the requirement for, and use of, tele-monitoring devices;
- the requirement for fault-tolerant and back-up systems;
- the requirement for date and time stamping for audit purposes;
- security and confidentiality needs;
- user acceptance of technology:
- impact on the organization.
- time management;

8.7 Forming Practice-Guidelines

Tele-consultations, especially those involving patients, must follow suitable guidelines. Initially, the format of a typical process-guideline, written as a checklist of the sequence of steps faced in the consultation process, was demonstrated. Here, the ways to design practice-guidelines to ensure an effective, safe and high-quality telemedicine service would be discussed. We should also reiterate the distinction between guidelines and regulations. Unlike a regulation, a guideline is not binding upon the practicing healthcare workers. It is a digest of perceived good practice, which may not seek comprehensiveness. In particular situations, the practitioners may therefore depart from it, if they judge that the divergence is in the interest of the patient. Let us look at some of the generic criteria for validating guidelines and their purpose. Naturally, a specific guideline must be written for every procedure, but the criteria are valid for all cases.

- *Objective of the Tele-Consultation:* In earlier section, stage 1 of the checklist was to 'explain the purpose and process to the patient'. In the context of validation, however, the guideline requires one to make clear the overall objective of the tele-consultation, i.e. whether it is diagnosis, treatment or the evaluation of a condition. This need is essential because the resources required, for the different procedures may differ widely. The guideline should therefore narrate the tele-consultation and medical equipment required, so that the clinician in charge can validate that the necessary resources are available.
- *Definitions of Duties:* In traditional procedures, responsibility for the patient's treatment and well-being lies with the clinician who is in charge of the intervention at that time. This person may be the patient's GP or consultant, or a surgeon, but he or she is always a qualified doctor licensed to practice medicine (and perhaps telemedicine) in the location where the intervention takes place. In telemedicine procedures, there is scope for ambiguity since there may be two clinicians involved, a GP with the patient and a specialist at the other end of the remote link.

  Alternatively, there may be a nurse or another healthcare professional with the patient who may act, to some extent, as a proxy for the remote specialist. The guideline must therefore make clear the competencies required of the various participants. It should also specify that these must be established, and the necessary authorizations received, before the tele-consultation can proceed.
- *Ensuring an Ethical Basis:* Normal rules of patient confidentiality and security apply to the storage and transmission of patient-data derived from telemedicine. Data may only be transmitted with the informed consent of the patient and only data relevant to the patient's condition and problem can be sent. These constraints are essential to preserve the patient-doctor relationship and the autonomy of the patient. For these reasons, the guideline should require that the doctor and patient can reliably identify one another at the start of a tele-consultation.
- *Ensuring Quality of Care:* We have already noted that participants in a tele-consultation must be satisfied that the technical standard of the equipment and its

operation, safety and security are fit for the intended purpose. These quality-considerations must also apply to the collection of data and to the documentation of the whole consultation, just as they would to a traditional patient-doctor interaction. Healthcare professionals at both ends of the telemedicine link may contribute to the record of the consultation and the notes should identify the authors of these contributions.

While the benefits associated with guidelines are highly desirable, they are not easy to achieve. Some of the most commonly cited limitations include the difficulty of getting the layout right and pitching the content at the right level, the threat to professional status, the perceived restrictions on good practice (change the guideline!), and the legal implications of a documented guideline that was not followed or that encouraged unsound practice.

8.8 Executing and Managing the Service

Telemedicine is a modern way of delivering medicine. Resultantly, its implementation will therefore disturb and even disrupt existing practices. Planned and sensitive change-management is therefore central to the successful introduction of a telemedicine service. Other critical success-factors involve the organization of hub and remote sites, data-collection and performance indicators, and development plans. We will look briefly at each of these factors (Essentials of Telemedicine and Tele-care by A.C. Norris, Department of Management Sciences and Information Systems, University of Auckland – New Zealand).

Managing change. The world is knee-deep in literature on change- management, much of it less inspiring than the trees from which the paper was made. There are nevertheless some useful theories and recommendations for effecting change. Key issues involve:

- understanding the present;
- setting goals and objectives;
- leadership;
- people's involvement and communication;
- overcoming resistance to change;
- keeping up the momentum.

Perhaps one of the most useful sources is Rosabeth Moss Kanter's book, The Change Masters. Her keen sense of the value of the individual as a contributor to a team, and her insight into why it is easier to introduce change into integrative (team-based) as opposed to segmented (hierarchical) organizations are valuable lessons for would-be telemedicine implementers. We have highlighted the importance of teams (at hub and remote sites) and champions, as well as the incremental rather than 'big bang' approach to change-management. Mitchell, in his evaluation of the renal telemedicine project at the Queen Elizabeth Hospital, Adelaide, adds system ease-of-use, training, goals, good organization and documentation as other contributors to success. Warisse has studied the changes in communication-processes that organizations experience as they implement new communication- techniques.

Organization of' hub and remote site. Pursuing the above points, implementers should ensure smooth arrangements for scheduling telemedicine sessions, and for reliability, security, documentation and technical support at all sites. Equal importance attaches to the integration of the new telemedicine services with existing services, to encourage their move into mainstream activity. System changes and interruptions should be advised well in advance of the events and carried out outside of normal service-times, wherever possible. This is all good systems- administration (and common sense) but it emphasizes credibility and encourages clinicians to use the facilities.

Data collection and performance indicators. The clinical results of tele-consultations and systems-operation data relating to these sessions underpin quality-assurance of the care process. The same data are crucial for setting performance-indicators and checking the achievement of targets. Essential data should therefore be collected on a routine basis and used to build an expanding database that allows managers to measure performance and instigate improvements. Here are some examples of operational data that define useful targets for this purpose: numbers of patients seen (including gender, age, ethnicity and social status); percentage of correct diagnoses via tele-medical link; numbers of patients with successful medical outcomes, compared with conventional care; travel time and costs for patients to attend tele-consultations; patient satisfaction with the service; number of patient-complaints; operational system hours; length of each tele-consultation or other session; out-of-hours usage: item and total costs, compared with budget allocations; amount of income generated. Demographic data, such as names of participants and the identities of the connected sites, should also be recorded.

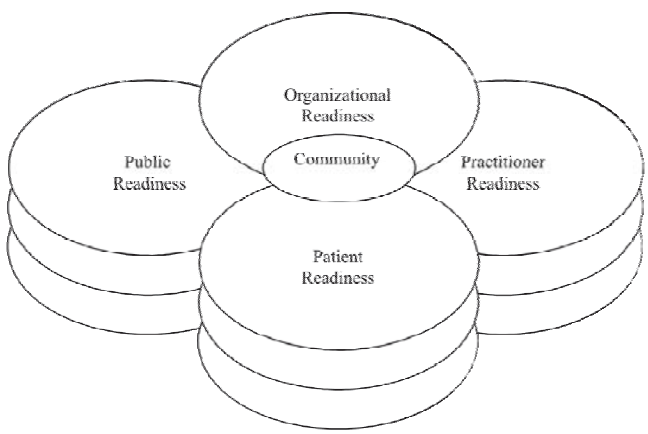

Figure - 1

Development plans. A successful service will lead to further developments, and so managers should be aware of new opportunities. These might take the form of added-value inducements to use services, the expansion of existing services, or the addition of new ones, such as treatment of new conditions or extension to other geographical areas. These improvements can even be packaged together, for example, by offering international, fee-based services to companies with employees on overseas business or to airlines or shipping organizations. In planning such developments, managers should take into account the impact on existing (including non-tele-medical) services and the likely effect of increased demand on system bandwidth.

9. EXPERIENCES OF SOME DEVELOPING COUNTRIES

9.1 Pakistan

Health Scenario It is a fact that health and social indicators of Pakistan are among the poorest. People in Pakistan suffer from a high burden of both infectious and chronic diseases, about one-third of Pakistanis live in abject poverty, and only 24% women and 54% men are literate. Poor nutrition and repeated infections have led to a situation where 30-40% of children in Pakistan suffer from stunting.

At the same time, chronic diseases, such as hypertension, have become prevalent; about 11 million people suffer from hypertension. While all population-groups are affected, children and women in their reproductive years have suffered most. Maternal mortality ranges between 350-700 for every 100,000 live births, and prenatal mortality rate is 54-92 per 1,000 births. In addition to focusing energies on social and economic development, this situation requires an optimally functional and fair health-system. The majority of people who live in poverty and cannot afford private health-care depend on the public sector. However, currently, the public-sector spending in health is at an extremely insufficient level of 0.9% of Gross Domestic Product.

Background

The Northern Areas are the remotest and under-privileged regions of Pakistan. The area has a population of around one million, living in more than 600 villages scattered over 72,496 sq. kms. The Northern Areas border with China in the North, Pakistan´s Kohistan and Kaghan areas in the South, Chitral in the West, and Indian-held Ladakh and Kashmir in the East. Administratively, the area is divided into five districts, namely Gilgit, Skardu, Diamer, Ghizer and Ghanche. Lack of access to communication capacities has directly affected the abilities of the local people to enhance and strengthen civil society and private endeavors to embark upon the path to sustainable livelihoods and to achieve the objectives of poverty-reduction and private sector development in the Northern Areas of Pakistan, which is one of the most remote and poverty-stricken regions of the world.

The people living in the northern areas consider unavailability of health- facilities as a major issue. Although, civil society and government interventions have, in recent years, achieved a marked increase in health- facilities, the remoteness of areas and difficult terrain still drive local women to rely upon traditional practices for pre-natal and post-natal health. Awareness about health and hygiene is still poor among remote communities and, therefore, is a strong focus of interventions by authorities and projects.

Keeping in view the deteriorating condition of the northern areas of Pakistan, a project with 'ICTs for Rural Development of Remote and Mountainous Areas of Northern Pakistan' was initiated in January 2004. Its overall objective is to experiment and to demonstrate the promotion of sustainable livelihoods and alleviation of extreme poverty in the remote areas, through action-research in the application and project of ICTs. International Development Research Centre (IDRC); the Crown Corporation is the principal funding organization and the Commission on Science and Technology for Sustainable Development in the South (COMSATS) Headquartered in Islamabad, have collaborated to make the first such project in the area a success.

Services

The project has been providing service in the following specialties:

Dermatology: Dermatology has been a successful Telehealth-care service across the globe and this has been experienced during this project. The reasons being (a) easy-to-use technology, (b) no specialized equipment required and (c) medical examination can be done well through pictures and videos, even without touching the patient. Most of the dermatological conditions are related with the climate and environment of the area, specially eczema and atopic conditions. Many recurrent conditions are reported due to the fact that there is no dermatologist in the area and the people keep on switching from one GP to another in search of proper treatment.

General Medicine: Next in importance, after dermatology, most of the patients come for General medicine consultation. A number of these patients are the ones referred by the General medical practitioner working at the OPD of the hospital where Telehealth center is established. The cases range from thyroid-related problems to hypertension and kidney-related disorders, etc. The problem being faced in this specialty is that the absence of a doctor at the remote end makes a doctor totally blindfolded, especially when it comes to examining a patient. Lack of facility for some medical tests, like thyroid function tests (which is quite prevalent in the area), also leaves a doctor crippled and unable to confirm a diagnosis; he is therefore left to treat and prescribe for the patient with the meager information that is available. This sometimes leads to very supple treatment of a condition which may be requiring some vigorous therapy.

Gastroenterology: Gastroenterology is also one of the fields which have a lot of potential to grow through Telemedicine. Many patients turned up to consult the gastroenterologist; most of them were suffering from some kind of acid peptic disease or gastritis. Worm infestation is also a common condition, due to lack of clean drinking water and poor level of hygiene. The major drawback faced in this field is lack of endoscopic facility in the area, due to which diagnosis cannot be confirmed or the patient has to be referred to Islamabad for this test.

Cardiology: Unexpectedly, relatively few cases turned up for the cardiology consultation during the last six-month period. The reason for this lesser number of patients may be that, since patients cannot assess themselves to be suffering from some cardiac problem (as they can in some other specialties), and the local physicians also need specialized tests and investigations to confirm the presence of a cardiac disease, therefore many cardiology cases are treated by the local physicians themselves under general medicine unless an emergency situation arises. Since Telehealth project does not handle emergency cases, therefore many such patients end up in the emergency wards of the local hospital or are taken to urban centers.

Problems and Solutions

Connectivity: Connectivity is the backbone for any Telemedicine service; either it is being provided through store and forward technique or involves some sort of live interaction between doctor and patient. Low bandwidth and loss of connectivity were the major problems for Telehealth. Although the Telehealth clinic was connected to the ISP through HDSL modem, which uses dead pair, the increased clientele of the ISP definitely affected the bandwidth available for data-transfer and videoconferencing. Weather conditions and physical damage to the copper wires also slowed down the link all the way, from one end to the other, i.e. Resource Centre Islamabad to VSAT-Skardu ISP to Telehealth Center Skardu. During the later phase of the project, a few measures were taken to overcome these problems using best possible solutions in the given circumstances as follows:

- The videoconferencing system was tuned to make the calls at 128k, so that the packet-loss can be minimized. This produced great improvement in the audio quality during consultations.
- Separate downlink-services were arranged from another service at ISP in Skardu, to make V- Sat link bandwidth available for Tele-health project. Only 32 Kbps, on the average, is being used by COMSATS internet service from the total 128 Kbps V - Sat link.
- Fine tuning was done at the ISP to decrease the choking and packet loss.
- The graphs of bandwidth-usage obtained from the ISP identified the time when the internet-usage was minimum and therefore effort was made to adjust the timings of the doctors accordingly, so that maximum bandwidth should be available at the time of consultation.
- The connection between the Telehealth center and ISP was lost twice, due to physical damage to the copper wires between the two sites, which halted the Telemedicine service for at least two to three days. Therefore, another alternate cable-link was made, so that it can be used if any such problem arises in the future.

Human Resource

Lack of general physicians or well-trained paramedical staff was one of the biggest issues during the Telehealth service. Most of the doctors prefer to go to bigger cities (either to gain experience or earn more) and only those who come to visit their families, or the female doctors with their spouses stationed in army units, are available. These physicians are available for only a limited period of time and many leave after a few months. Paramedics are also deficient in that area and very few of them are trained enough to meet the needs of Telemedicine. The following steps were taken to cope with this problem:

- A doctor dedicated to the Telehealth service at Abdullah Hospital Skardu was employed, so as to present accurate (as far as possible) and detailed data of the patients to the Specialists, especially cardiologist and medical specialist. It was preferred that a female doctor is hired to cater to a large number of female patients in Telehealth. The doctor was guided and supervised by the specialists themselves, according to their own requirements.
  All the specialists opined that the quality of consultation was much better and satisfactory when there was a supporting doctor present at the remote site to provide the basic data. Otherwise, the consultation was manageable but not to the satisfaction level of the specialist.
- The computer operator who is responsible for running the Remote Telehealth center equipment has gained a lot of knowledge through hands-on training. His medical background as a sales representative of a pharmaceutical company and guidance by all the doctors at Telehealth center and Resource center has also helped him to gain this knowledge. The person is now able to take a good relevant patient-history, do general physical examination e.g take BP, Pulse, temperature, look for thyroid and anemia, etc, in the absence of a general physician at the remote center. This implies that, if given proper training and with good experience, paramedic staff can become a substantial help when a doctor is not available for conducting Telemedicine, but, still the General Physician will be the person of choice, as many symptoms and signs of the disease may still be overlooked by the paramedic (especially those related to the systemic examination of the patient).

Patient-Information Software

Since the number of patients increased afterwards, therefore patient- information software proved of great help especially in: searching for the medical record of the previous visits, searching for the serial number of the patient who do not remember their record number, and it was easy to use. Problems that were encountered in this software were the lack of the print-command, which hindered the printing of the patients' prescription and there were problems in the transfer of the pictures of the patients for the far end to resource-center. To sort out both these problems, FTP-server was used, where pictures and prescriptions were uploaded and downloaded across the two ends. In addition to this, a FTP server was placed at the ISP to increase the rate-of-transfer of files, as well as to avoid undue delays in the transfer during power-failure or problems in the computers. This option has fixed the problems to some extent, leaving behind only the problem that now the whole data of the patient cannot be accessed from one program, making it a bit time-consuming.

Since the project aims at the development of such a system of Telehealth which is less dependent on the live-consultation, therefore it was realized that there is a need to provide the patient-data to the specialists at their workplace (of homes) so that they can study the case well, send their queries, suggest tests and prescribe (if possible) without coming to the resource-center. The visit to resource-center should be limited for the live- consultations, only when really required. Since the existing software lacked the ability to transfer pictures and documents quickly, and most specialists have dial-up connection for internet, therefore it was decided that a web portal will be employed for the transfer of patient-data to the specialists.

Conclusions

Although the Telehealth service seemed a big task and many of the problems were difficult to cope, nevertheless the team efforts and enthusiasm of all the persons involved in the project made it workable so that it can be claimed that many people, especially women and children, have benefited a lot from this service. Those who were unable to go to urban cities to get specialist advice have now got the facility within their reach, thereby easily relieving them of the diseases and conditions from which they had suffered for many years. There is still a lot to be done, including improvement in quality of patient data transfer and live-images, which can be made possible with fiber-optic cables instead of satellite link, as also to make the service economical and sustainable to benefit a larger population. The economy can be achieved by using digital cameras or newer versions of web-cam (instead of specialized videoconferencing equipment), which provide high resolutions and low pixels. In future, the resource center can be established at a hospital to save time of both the doctor and the patients.

The patients, masses and health professionals should be educated and informed, as much as possible, about telemedicine so that they do not feel alienated to this method of health-care delivery. This will make it possible for the future generations to feel at ease in using this technology, either wholly or as an adjunct to the traditional methods of healthcare.

9.2 Malaysia

The healthcare challenges that Malaysia faces today are not dissimilar to those encountered in other developing and developed countries. These countries face the problems of rapidly rising cost of healthcare, as governments struggle to deal with issues, such as aging populations and Western “chronic” diseases, that consume an ever-increasing allocation of their health-budgets. As Malaysia enjoys growing affluence and marches to a developed country status, its causes of medically related deaths have similarly switched from infectious diseases to Western “chronic” diseases of cardiovascular, cancer, diabetes. Similarly, Malaysia’s aging population (over 65 years of age), will nearly double from 3.9% in 2020 to 7% by 2020 although this is low compared to its Asian neighbours (eg Japan will have over 25 %) in absolute percentage term. Malaysia has been working towards a common future in all sectors, called Vision 2020. Health-status is a key-component of that vision, and information and communications technologies are considered an important enabler. Over the past 5 years, there has been considerable activity in implementing computer-based solutions to assist healthcare practitioners and the first paperless hospital has been implemented. There are a number of challenges in implementing the vision: 1) changed management; 2) lack of communications-infrastructure; 3) integration into healthcare-practice; and 4) privacy issues related to health data. The country continues to work toward a vision, of which telemedicine is a flagship application.

Malaysia's Integrated Tele-health Solution

Malaysia's integrated Tele-health solution consists of: Lifetime Health-Plan (LHP), Mass Customised/Personalised Health Information and Education (MCPHIE), Continuing Medical Education (CME) and Tele-consultation.

Conceptually, the four applications have been developed around the premise of a series of patient/doctor encounters spanning a lifetime from womb to tomb, encompassing both wellness and illness. At each of these encounters, the four applications will play their roles to benefit both patient and the health-provider optimally.

The Lifetime Health-Plan application, which forms the crux of the solution, aims to keep users in the wellness paradigm as long as possible. It comprises Clinical Support System (CSS) and Healthcare Information Management and Support System (HIMSS). The Clinical Support System is designed to support the collection of electronic medical records, which includes hospital, clinical, laboratory and pharmacy information at each doctor-patient encounter and to meet the administrative and clinical needs of the healthcare providers. The healthcare provider will also have real-time access to reference material, such as clinical practice guidelines and a virtual library, through the Continuing Medical Education application.

Healthcare Information Management and Support System is the repository of lifetime health-records necessary to produce the Personalised Lifetime Health-plan, which delivers a personalised, proactive and prospective health-plan to keep the individual in the highest possible state of health. It allows patient-information to be stored and retrieved electronically independent of time and location, to ensure more accurate diagnosis, effective treatment and continuum of care. The lifetime health-records will also form the basis to produce statistical and trend analysis of the nation's health-status, which will be invaluable to the policy-makers to effect an efficient allocation of resources.

Mass Customised Personalised Health-Information Education is about creating and delivering customised health-information, education and advisory content to the individual-user, based on his/her electronic medical records, thereby empowering the user with knowledge to make informed decisions regarding his health. The main objective of this application is to enhance the preventive and promotive approach of the Ministry of Health to manage the nation's healthcare. The Ministry of Health will vet the content, and acccess will be through a web portal and a call centre.

The Continuing Medical Education application is concerned with the provision of information and education programmes for healthcare- providers, to maintain and upgrade continuosly their knowledge, competence and skills related to their medical and healthcare practice. There will also an online professional community for the healthcare- providers.

Tele-consultation serves as as an efficient channel for healthcare- providers to access medical and health expertise from locations where such resources are not available.

To provide broad access to the public of the health-information and education and to give healthcare-providers an alternative means to enter, update and retrieve electronic medical records, the solution will include a call center. This will allow the public, through the telephone (who do not have computers or internet access), to make enquiries and receive information on health-related matters and all the services provided by both Lifetime Health Plan and Mass Customized Personalised Health Information and Education.

Acceptance of any solution by the stakeholders in the industry is critical. By creating an "integrated" solution, which offers strong value-propositions to all the stakeholders in the healthcare system — patients, healthcare providers and administrators/policy makers/researchers — Malaysia's tele-health application solution is more likely to be embraced by everyone. For example, the value propositions to the various stakeholders are:

- To the patient
  - Continuum of care, via electronic medical records
  - Increased accessibility to health-information
  - Personalisation of health-plans for individual
  - Personalisation of health-information and education
- To the healthcare provider
  - Support in managing daily tasks including patient-scheduling, patient diagnosis and follow-up
  - Access to real-time medical information (e.g. Cinical Practice Guidelines and Virtual library)
  - Improvement of medical skills and knowledge
  - Establishment of a dynamic online community of healthcare- providers
- To the policy-makers/administrators/human-resources personnel
  - Creation of databases for health-statistics, to help health-policy planning and allocate scarce resources
  - Reduction of healthcare-cost
  - Increase productivity, through improved health

9.3 India

In a developing country such as India, there is huge inequality in health-care distribution. Although nearly 75% of Indians live in rural villages, more than 75% of Indian doctors are based in cities. Most of the 620 million rural Indians lack access to basic healthcare facilities and the Indian government spends just 0.9% of the country's annual gross domestic product on health, and little of this spending reaches remote rural areas. The poor infrastructure of rural health-centers makes it impossible to retain doctors in villages, who feel that they become professionally isolated and outdated if stationed in remote areas.

In addition, poor Indian villagers spend most of their out-of-pocket health- expenses on travel to the specialty hospitals in the city and for staying in the city along with their escorts. A recent study conducted by the Indian Institute of Public Opinion found that 89% of rural Indian patients have to travel about 8 km to access basic medical treatment, and the rest have to travel even farther.

Initiatives

Telemedicine may turn out to be the cheapest, as well as the fastest, way to bridge the rural–urban health divide. Taking into account India's huge strides in the field of information and communication technology, telemedicine could help to bring specialized healthcare to the remotest corners of the country.

The efficacy of telemedicine has already been shown through the network established by the Indian Space Research Organization (ISRO), which has connected 22 super-specialty hospitals with 78 rural and remote hospitals across the country, through its geo-stationary satellites. This network has enabled thousands of patients in remote places, such as Jammu and Kashmir, Andaman and Nicobar Islands, the Lakshadweep Islands, and tribal areas of the central and northeastern regions of India, to gain access to consultations with experts in super-specialty medical institutions. ISRO has also provided connectivity for mobile telemedicine units in villages, particularly in the areas of community health and ophthalmology.

Other then that, both public and private entities are aggressively pursuing the use of telemedicine to hasten diagnostics and treatment of a variety of diseases in India. Private hospitals such as Apollo Hospital Group, Escorts Heart Institute and Fortis Healthcare. The Apollo Hospital Group has networked dozens of remote rural hospitals providing digital connections to one of its main facilities in. In one example, Apollo has set up a 50-bed telemedicine center in Aragnoda, a small village in the Andhra Pradesh section of south India. The facility is equipped with CT-scans, X-ray and ECG equipment as well as an integrated laboratory and is linked to Apollo's specialized hospitals with connectivity is conducted through the use of ISDN lines and VSAT. The Indian government has also made important commitments to telemedicine by reducing import tariffs on infrastructure equipment.

Hindrances to Telemedicine

Financial unavailability: There have been several isolated initiatives from various organizations and hospitals for the implementation of e-medicine projects in India; but the technology and communication costs, being too high, make it financially unfeasible.

Lack of basic amenities: In India, nearly 40% of the population lives below the poverty-level. Basic amenities like transportation, electricity, telecommunication, safe drinking- water, primary health-services, etc., are missing. Any technological advancement can't change a bit when a person "has nothing" to change.

Literacy rate and diversity in languages: Only 65.38 % of India's population is literate, with only 2% well-versed in English. So the rest of the people are facing a problem in adopting telemedicine. Also, the presence of a large number of regional languages makes the applicability of a single software difficult for the entire country.

Advantages of Telemedicine in India

- Doctors licensed to practice all over India
- Maximum utilization of limited resources
- Saves travel, time and money
- Make geographical history
- Motivation for computer literacy among doctors
- Useful in designing credits for re-certification of doctors

A time is approaching when telemedicine/e-health initially shall be visibly practiced in the majority of Indian hospitals, as a separate department, before eventually fusing into the respective medical specialties.

9.4 Nepal

Nepal is one of the world's poorest countries, where most people live in the mountains, without access to basic medical treatment. Patients have to travel long distances to hospitals in the capital, Kathmandu, for treatment. Patan Hospital is partly a Mission-run hospital in Kathmandu, offering general medical, surgical and obstetric care. Specialists in other fields are not available, so patients requiring specialist advice on diagnosis and management have to be referred to other hospitals in Kathmandu, with attendant costs and delays. It was felt that, in selected cases, this problem could be overcome through the use of telemedicine to provide expert medical advice from afar. The usefulness and cost-effectiveness of telemedicine in developing countries, where finances are restricted, cannot always be assumed, but requires evaluation in pilot-projects in each country.

Store and forward telemedicine, using e-mail and a digital camera, is much less expensive than real-time telemedicine using video-conferencing equipment and ISDN lines. A simple store and forward telemedicine link was therefore established in Patan Hospital, in March 2000. This pilot-project aimed to explore the technical feasibility and benefit of low-cost telemedicine, in terms of making a diagnosis and management-plan for patients in this developing country.

Methods

Any patient, aged 16 or older, attending Patan Hospital who needed specialist medical advice during a 1 year period from March 2000 until February 2001 was included in the study. Permission was requested from each patient before using the telemedicine link. Each referral was coded according to established protocols. Patient details, i.e. name, hospital number and address, were not recorded on any e-mail. An e-mail referral detailing the history, examination and questions to be answered was sent to the specialist and copied to coordinators at the Swinfen Charitable Trust. Where needed, a digital image was sent along with the e-mail. The main Trust-coordinator checked e-mail referrals three times daily. Specialists offering their advice, free of charge, were available in neurology, renal and respiratory medicine, dermatology, radiology and cardiology. There specialists were from the UK, Australia, Bangladesh and the USA. Specialists sent their replies to Patan and copied them to the coordinators. Speed of specialists' reply was recorded. Appropriateness, benefit of the reply for diagnosis, management and education, were each scored by two independent assessors using a five-point scale: very unhelpful, unhelpful, neutral, helpful, very helpful. Whether the advice was acted upon or not was also recorded.

Results

Forty-two telemedicine referrals were sent during the 12-month period. Eight requested advice on general management of certain conditions and 34 were patient-specific, asking for diagnostic or management advice. On two occasions, there was a 10-hour delay in sending referrals due to difficulty in connecting to the Internet.

Referral types were 36% respiratory, 21% neurological, 21% dermatological, 14% cardiology, 5% nephrology and 3% radiology. Twenty-eight referrals had digital pictures attached – in 82% of cases only one digital picture was required. Of the pictures sent, 45% were chest X-rays, 31% were skin lesions, 10% were electrocardiograms, 10% were computerized tomography scans and 4% were magnetic resonance imaging scans. One digital picture of a chest X-ray was of such poor quality that the specialist was unable to offer any comment.

In three cases, the specialist did not reply. In the 39 referrals where replies were received, the average speed of specialists' reply was 2 days. The average reply time for each specialty was: radiology and nephrology – 1 day; neurology and cardiology – 2 days; respiratory medicine and dermatology – 3 days.

One specialist reply for dermatology came after 11 days, because the specialist was on holiday and, due to a problem with his computer, the coordinator had not received a copy of the referral. This led to a breakdown in the re-referral process. This re-referral process is used when a telemedicine specialist, for any reason, does not reply within 3 days. The coordinator would then ask another specialist to offer advice. Interestingly, this patient was also referred to a specialist in Kathmandu at the same time as telemedicine referral, and was seen by him on day 9. Despite a change in treatment advised by the Kathmandu specialist, the patient died on day 11 (from immunosuppression and haemorrhagic herpes zoster). The telemedicine specialist made the same diagnosis from the digital photograph as the Kathmandu specialist. Specialists receiving referrals at their private e-mail addresses replied more quickly, on the average, than specialists with a hospital e-mail address. The assessors judged that all specialist-replies were appropriate for a developing world hospital and the restricted tests available there. Seventy-three per cent of replies were helpful, and 27% very helpful, for establishing a diagnosis – 57% were helpful, and 43% very helpful, for making a management plan – 77% were helpful, and 23% very helpful, for education.

From the 34 patient specific referrals, the specialist advised a definite change in diagnosis or management in 23 cases. Where different management was suggested, this was in 58% of patients half as expensive as the management being undertaken in Patan Hospital. For 42% of those for whom more expensive management had been suggested, the cost was approximately a quarter more expensive. In the referrals where different management was suggested by the specialist, the management was not changed in 33% -– two were improving on current treatment, for two the antibiotics suggested were not available in Nepal, and one patient had died. The assessors decided that in 50% of cases the advice, if acted upon, would have shortened hospital stay.

This pilot study has shown that a low-cost telemedicine link is technically feasible; it is of great educational value, and it can be of significant benefit for diagnosis and management of medical conditions in Nepal. It can readily be emulated elsewhere in the developing world.

10. RECOMMENDATIONS & CONCLUSIONS

10.1 Recommendations

Taking into account the additional difficulties associated with setting up tele-health in developing countries, it would be prudent to utilize tele-health technologies that are relatively inexpensive, robust (do not break down) and are easy to operate and repair. It would also make sense to choose activities that result in a high degree of benefit for as many people as possible.One must also take into account what technology is available and what can be supported. Keep in mind that the technology chosen should be compatible with the technology used by those who will meet your needs. Technology should also be chosen to first meet immediate health-care needs.

Secondly, for realizing all the potential benefits of tele-health, it has to be designed, implemented and supported properly. Although we cannot go into depth regarding all the issues that need to be taken into account, the following list highlights the ten major issues that need to be addressed:

The Major Issues

i) Government, healthcare professionals and industry, all have roles to play in harnessing the drivers to overcome the barriers and achieve the benefits in the field of telemedicine and tele-health. We will now examine these three roles a little more closely.

- *The Role of Government*

  In a welfare system (e.g. the UK), the government is both the major (often monopolistic) purchaser and provider of healthcare for its citizens. In contrast, in a largely private-funded healthcare-system (e.g. the USA) the government's role is mainly to produce a framework in which market forces operate. Whatever the system, however, all governments regulate healthcare by the laws they promulgate, since these precepts determine the legal and (often) ethical environment in which healthcare professionals, managers and others function. Governments also support healthcare by the priorities they establish and the developments they promote.

  In the commercial sphere, the governments of all developed countries realise the importance of information and communications technologies (ICTs) for national competitiveness. If they establish business environments that encourage investment, entrepreneurial activity and risk-taking, then they will stimulate interest in new ICT application areas, such as telemedicine and tele-care. These policies will also open up new markets and export-opportunities for telemedicine products and services.

  These comments reveal the strength of the relationship between health and a nation's legal, social and economic frameworks. For telemedicine, they expose the importance of governmental policy and strategic direction-setting since these actions dramatically encourage or inhibit developments.

Where policy is fragmented or underdeveloped, it is difficult for telemedicine initiatives to flourish. Thus, despite Japan's reputation as an integrated and technocratic country; the diffusion of telemedicine has fallen well below expectations. This failure is attributed to the conflicting objectives of local and central government, which hinder knowledge-transfer and lead to a lack of coordination between government, users and manufacturers.

In short, the role of governments is to define standards and provide technological infrastructure/services required for the use of telemedicine, tele-education and tele-training. Governments in the developing countries need to set up incentives to promote telemedicine (e.g. reduction of tax-rates on equipment and of telecommunication service tariffs, introduction of rates for rural areas that are equivalent to those for urban areas, preferential flat-rates, etc.).

- *Healthcare Professionals*

  One important role of healthcare-professionals in advancing standards of healthcare and best practice has already been mentioned-the advice given to government to frame policy, legislation and guidelines. Clinicians and other healthcare professionals are uniquely qualified to provide this advice but, by virtue of their claim of clinical autonomy, they are also uniquely placed to block development if it counters their interests (usually status or financial). Issues of licensure and reimbursement, therefore, top the list of barriers to progress. In addition, the technological aspects of telemedicine and the intrinsic lack of direct, face-to-face contact with patients disturb some clinicians, who find that such practices undermine the traditions they have been taught to value and believe are in the best interests of their patients.

  In contrast, other practitioners have embraced telemedicine and the technology with enthusiasm. These individuals have a major role to play in working with their sponsors to research and create the circumstances in which telemedicine is a well-accepted adjunct or alternative to face-to-face consultation.

  Finally, we recall that continuing medical education is closely linked to the practice of telemedicine. Healthcare professionals have an obligation to contribute to, and avail themselves of, the opportunities to improve their own skills and the medical services they deliver to their patients. We see once again that the roles we have identified are discharged not in isolation, but in collaboration with government and industry. This integrative approach is worthy of further comment.

- *The Role of Industry*

  Healthcare is today the world's largest industry, accounting for 8% of the total world-product. Of this total, 15% is attributable to the mostly global pharmaceutical sector, 4% is due to medical equipment, and another 1.5% is credited to health-information systems and technology systems, a sector dominated by a decreasing number of international companies. With its ability to deliver healthcare across national frontiers, telemedicine is poised to become a significant contributor to this industrial output.

  An important role of an industrial supplier (if they want to prosper) is to produce equipment that the purchaser wants to buy. In the field of telemedicine this means mainly telecommunications products and infrastructure, or general-purpose videoconferencing equipment, perhaps modified to meet clinical requirements. Industry should therefore work with the legislature to establish telecommunications standards and to sell devices that conform to these standards.

  Another function is to design and build hardware and software that are not only highly reliable but also easy to use. It is important that carers and patients involved in tele-consultations can concentrate on the healthcare issues and not need to respond to technical diversions. Authorities may assist requirements by issuing standards of accreditation that products have to satisfy before they are 'fit for the purpose'.

  The evolution of new products and ways of working presupposes investment in research and development (R&D) to exploit the latest technology and ideas. Companies need to support their customers with medium- and long-term strategies for product development that are, nevertheless, flexible enough to respond to scientific advances. Once again, the state can encourage R&D by tax breaks and other incentives.

  But government may not be able to exercise its control as extensively and as exclusively as in the past. As business becomes more and more global, national frontiers begin to lose their significance, and commentators speculate that multinational companies will start to act as quasi-governmental organizations. Whether this happens or not, administrative policies; that are friendly to business and companies collaborating with healthcare professionals would be powerful partnerships to promote the development of telemedicine and tele-care . After this general overview of strategic issues, let us look at the frameworks adopted by various countries to facilitate the development of telemedicine.

ii) Given the state of economic crisis that developing countries are experiencing, and the limited resources of a State which must cope with enormous demand for supply of services and basic infrastructure (roads, schools, electricity, telephones etc.), the financial support for strategies to introduce telemedicine into developing countries must in essence rely on external finance. Such finance can be granted in the form of aid from industrialized countries, credits granted by backers, or support for implementation of pilot-schemes for operational applications of telemedicine and distance health-care by specialist international organizations, such as UNDP, WHO, UNESCO and others.

iii) Observing the technological barriers, administrations should work together to ensure that policies are in place at the national level to expand and introduce interoperable telemedicine networks that can be used effectively to improve the quality of health-care delivery, worldwide.

iv) Establishing a team of individuals to create a strategic plan for the design, implementation and evaluation of the tele-health network. This team will oversee and manage the initial rollout of the project.

v) Reviewing the previous tele-health activities that have occurred in a region, country and other similar locations and learning from the successes and mistakes of the developed countries.

vi) Conducting a resource-inventory is also helpful. This includes an inventory of any current tele-health technologies and telecommunications that are, or could be supported in an area. It also includes an inventory of human resources, e.g. people who have been involved in tele-health and / or those who are interested in participating in the future.

vii) Develop an educational package and disseminate this to all individuals potentially affected by tele-health. This will educate people about tele-health and prepare them to answer questions in the Needs-Assessment. Results from the needs-assessment will help to direct what clinical, educational and administrative needs have priority. It will also help identify people who are interested in tele-health.

viii) Reviewing, establishing and formalizing relationships with potential sites (referral and remote).

ix) *Matching the needs* (identified by the Needs Assessment) to the ability to meet the needs via tele-health (obtained from referral centres). The ability to meet the need includes having health- professionals who want to use tele-health technology to meet the need.

x) *And finally, Overcoming Tele-Medical Malpractice*

There are some operational risks that can cause adverse incidents during tele-medicine practice. Therefore, there is a great need to oversee all these factors while operating telemedicine. The clinical risks that have to be taken care of can be divided into the following categories:

a) Inadequacies due to technology
b) Inadequacies due to insufficiencies of personnel

a) Addressing technology risks

Quality of Images: A patient has the right to hope that a consultant can draw the same, accurate, conclusions from an image on a telemedicine display-screen as he or she can decide from a usual face-to-face consultation. This is especially important for pathology, dermatology and radiography investigations. Considerable work has been done by radiologists to define the degree of data-compression that can be tolerated before X-ray image-quality suffers to the point of producing unacceptable clinical errors. Other disciplines need to follow this lead, to assess and manage the risks of error and litigation.

Proper Functioning of Equipment: The collapse of computer or video equipment is unfortunately one of the more common features of telemedicine. The errors are usually simple and traced to the interfaces between the various components. However, the effects can be just as devastating and as fatal as more serious defects.

Adequate Guidelines: A guideline can be viewed as a bridge between the technology and the participants in the tele-consultation. Both types of guideline are used to establish a high-quality and consistent standard for the tele-medical consultation. The guidelines determine the process of tele-consultation, while the documentation provides a record of therapy, prescriptions, drug dosages, future plans, etc. This combination of protocol and record of action provides a powerful audit trail that can be of considerable value in any legal dispute. The protocol might also be of benefit to the patient's case if it was not followed correctly, but the advantages of a protocol to a defendant invariably outweigh the risks.

b) Overcoming risks Due to Personnel

Proper Communication: A protocol is helpful in identifying the stages of a tele-consultation where special care is needed to ensure clarity of communication between participants. Deaf and elderly patients are particularly prone to misunderstandings, as are patients (and doctors) whose native tongue is not the language of the consultation. Even if everyone speaks the same language, the accent, dialects, and distorted audio and video images can conspire to introduce misconceptions, with potentially serious implications. Reviewing the record of a tele-consultation (see above) is also helpful to check for errors, for example, in prescriptions and drug-doses, directions to the patient and follow-up appointments. There should also be a protocol for reporting errors that do occur, since an audit of mistakes is valuable in preventing further occurrences and establishing good practice. Naturally, this requirement presumes a culture in which the reporting of errors is not discouraged by fears of speculative litigation.

Qualified Staff: The employment of under-qualified (and unqualified) practitioners in clinical radiology reflects the shortage of posts in this area. This is a worrying situation since, as one study showed, non-specialist doctors had an error-rate in detecting potentially significant abnormalities that was nearly 40% higher than consultant radiologists. Hopefully, tele-radiology and greater access to consultants will begin to alleviate such problems. Even so, the problem is symptomatic of a health- service under stress, due to underfunding and/or poor management.

Meaningful Training: Ideally, training should include not only the clinical aspects of tele-medical treatment but also the ability to use the technology effectively, as well as interpersonal and interviewing skills. Failure to address these issues can lead to accusations and court proceedings for negligence.

Proper Delegation: The delegation of care to less well-qualified subordinates and the necessity of establishing their competence has also come to our attention several times throughout our discussion. If a task is beyond the competence of a delegate, then the ultimate responsibility reverts to the delegating clinician. If the delegate is competent to discharge the task, then he or she shoulders the responsibility. Either way, it is essential for the patient's safety and well-being that subordinates make it clear if they are proficient in the tasks they are asked to perform. As we have seen, telemedicine may unwittingly increase the opportunities for improper delegation, and therefore litigation, due to the remote nature of the care-process.

Clear Responsibility: The requirement of clear responsibility for a telepatient's care is no different from that of a patient treated by conventional medicine. An issue for tele-medical care may be the number of medical staff involved in the process, and due diligence on the part of the lead clinician is necessary to ensure that each member of the (often frequently changing) team is aware of their own responsibilities and those of other members. The patient should also know who is in charge of his or her care. These are simple precautions to avoid malpractice or negligence complaints.

Box - 4: Tele-health: Future Technologies and Applications Technologies

Wireless communications
- Mobile phones with Internet access will outnumber PCs with Internet by 2002
- Internet connectivity will be more pervasive, combined with a rapidly increasing number of people having access to the Internet
- People will not be bound to a computer (or a telephone line, especially relevant in rural areas) in order to have access to the Internet

Satellites, fibre optics, and cable
- Work is currently under way to use existing power lines to transport data, which opens up the possibility of high bandwidth access for any area connected to a central power grid
- Internet 2, currently under development, is expected to be between 100 to 1000 times more powerful than today's Internet

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Increasing convenience, processing power, and storage capacity

- Computers will move away from the traditional PC to smaller, more discrete devices that are more convenient and accessible to those without any PC training
- Computers will be more common in everyday appliances
- DSP - Digital Signal Processors-running at 1.1Ghz, processing 9 billion instructions a second
- Video, audio, data, image – improved technology available at reduced cost

The networked household

- It will soon be possible to network appliances within the household, using existing electrical cabling
- Appliances will be connected to, and controlled by, a server (PC) -- lights, power, refrigerator, oven, television, video, etc
- This has obvious applications in home-based care

APPLICATIONS

Home-based healthcare

- Health-care will focus on the patient at home, rather than in an institution
- Continuous monitoring (heart monitoring, detecting delirium, etc) via wearable devices (so small that they will not interrupt daily activity) will be remotely connected to a central point or to a specialised monitoring station located in a hospital. This will reduce response-time and add a level of safety for people living alone or in isolated communities
- Nursing care will be delivered remotely to the homes of patients. Using devices, such as the Kodak Care Station, it is possible to check blood-pressure, temperature and have a face-to-face videoconference with a nurse over a standard phone-line. With bandwidth likely to expand ten to a hundred-fold, the possibilities for remote delivery of healthcare become boundless • Patients will be able to leave hospital sooner and receive a higher level of care, improving continuity of care
- 46% of all activities carried out by on-site nurses could be replaced by telemedicine.

Accident and emergency

- Improved remote diagnosis, with audio and visual capabilities
- Emergency personnel will have specialist knowledge at their fingertips, using a wireless device to communicate to hospitals, specialists, GPs
- Immediate implementation of the most effective trauma procedures

Surgery

- Surgery becomes a flow of electronic data, with sensory input transmitted to the surgeon and his or her response transmitted back to mechanical intervention, such as a robot
- Sensory devices, such as sound, touch (force feedback), will create virtual surgery which will enable simple procedures to be done remotely, using robots and real-time data exchange
- Robotics and nanotechnology can be used in remote surgery applications
- It will be possible to incorporate more information (patient history, vital signs) into the surgery-procedure, so the surgeon has access to a wider range of more up-to-date information

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Rural and remote areas

- In future, a visit to the doctor could consist of going to a tele-health centre staffed by a trained nurse, where all necessary testing is done and transmitted in real time to pathology labs and specialists, possibly over large distances International telemedicine

International Telemedicine

- Countries could viably sell their medical and healthcare skills, using tele-health, to other countries
- The local GP's office could conceivably consist of specialists from around the world

Wooding, Robert. (2001). "National Telehealth Plan for Australia and New Zealand": http://www.health.gov.au/internet/hconnect/publishing.nsf/content/7746b10691fa666cca257128007b7eaf/$file/teleplan.pdf

10.2 Conclusions

- In short, although telemedicine and tele-health have many socio-economic benefits, can generate new sources of revenues for service-providers and equipment-suppliers and can optimize the use of available human and capital resources in developing countries, it is important to recognize that investing in a telemedicine and tele-health delivery-system will cost something and that something will be competing for scarce resources in developing countries. External support and funding, i.e., outside the developing countries, can be contemplated, but the sustainability of the delivery-system -- of the value-chain -- should be scrutinized carefully before committing significant capital.
- The success of the telemedicine service will also depend heavily on which technologies and services are used, on how appropriate they are to particular countries, recognizing that the situation can differ from country to country. Or, to put it another way, what may work in one country may not meet the needs of another country.
- There is no doubt that telemedicine offers great opportunity as an alternative method of health-service delivery to rural areas. Although there are many examples of successful applications of telemedicine in a wide range of clinical practice settings, more research is required to prove their clinical and cost effectiveness. While considering a new telemedicine application, it is important to consider a range of logistical factors. A common and expensive mistake for developers of telemedicine-service is to focus entirely on the technology. It is essential that one considers the significant organizational changes that are required for telemedicine to be integrated as a mainstream health-service. There should always be a clear reason for doing telemedicine, such as a proven clinical problem where online-communication technologies may be helpful for the delivery of a health-service. The telemedicine service should be subject to robust evaluation in order to determine the benefits over conventional services for the health-service provider, the consumer and for society as a whole. It is recommended that new services be piloted on a small scale and gradually

developed, if proven beneficial. To conduct telemedicine successfully, it is important that all sites involved are well-resourced with the appropriate personnel, equipment, telecommunications, technical support and training.

- It is a fact that telemedicine is beginning to have an important impact on many aspects of health-care in developing countries. When implemented well, tele medicine may allow developing countries to leapfrog over their developed neighbours in successful delivery of health-care.

Box - 5: Comparing the Health Systems of 2002 and 2022

There are many similarities between the health-systems of 2002 and 2022, but there are also some important differences:

- Patients take greater responsibility for their own health and care, they are involved in many more decisions, including options of various forms of additional treatment and care-insurance. They use knowledge-resources themselves and with patient- advisors to help with these decisions.
- Patient/Consumer associations play a much stronger role in monitoring quality and advising patients. They also help to channel local voluntary care.
- Poverty is still a major cause of poor health; problems of social exclusion are exacerbated by information-exclusion.
- A higher proportion of health and care services are provided in the home or primary-care setting, accounting for 35% of health costs (c. f. 27% in 2000).
- Medical technology and pharmaceutical advances have accelerated, but developments are better targeted to provide cost-effective solutions.
- A higher proportion of costs are devoted to health-promotion and disease-prevention, including genetic screening, counselling, empowerment-based behaviour-change and positive mental-health programmes.
- Evidence-based medicine guides the development of health-solutions and their application by clinical teams in primary and secondary care.
- Primary and secondary care are better integrated, working together, following agreed evidence-based guidelines. This results in greater uniformity of practice, compared with 2000 when primary-care doctors with similar patient-communities would differ by 250% in their referral rates.
- Professional boundaries have been reduced between: patients and clinical staff, doctors and specialist nurses and between professional carers and volunteers.
- Services are limited to those that can be shown to be effective. This is the main way in which services are rationed, though there are also some limits on very high-cost procedures and some age-related limits.

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- The quality of treatment and care is much better, long waiting lists are not considered acceptable, neither is it accepted that specialists should offer private consultations because their public waiting-list is too long. Junior Medical staff is not expected to work excessive hours or to practice without close oversight by senior staff, either in person or by video-link. The quality-experience of every patient is monitored by Patient /Consumer groups.
- European health-systems are quite similar in the way they work, with commissioning agencies working with primary-care networks, even though there are still differences in the funding and structure of systems.
- Primary-care forms the gatekeeper for health-services and guides patients through the health and care services.
- Hospitals provide the knowledge-centres for the healthcare system and are usually organised around emergency services and specialist units that bring together specialties with similar requirements of resource and skill.
- Communication and information-systems provide a seamless knowledge-base for health and care. They are an everyday part of everyone's life.

Dr Graham Lister The Nuffield Trust Dec 1999/ Updated Jan 2002

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GLOSSARY†

ATM
Asynchronous Transfer Mode
A way of transmission where a start signal precedes individual characters and one or more stop signals follow it. Due to this start/stop system, delays may occur between characters. Also denotes the complete system of protocols and equipment associated with cell based communications network. These networks have the ability to transmit voice, data, and video traffic simultaneously using a statistical multiplexing scheme. This type of switching is expected to bridge the gap between packet and circuit switching. ATM uses packets referred to as cells that are designed to switch cells so rapidly that there is no perceptible delay.

Audio-teleconferencing
Two way communications between multiple people at various locations.

Automated Data Collection
The direct transmission of physiological information from monitoring devices to either a bedside display system or a computer-based patient record.

Backbone Network
A high-speed, high capacity transmission facility created to interconnect lower speed distribution channels from smaller branches of the computer or telecommunication network.

Bandwidth
Measures the ability of a communications channel to carry information. The capacity of information increases relative to a higher megahertz (cycles per second) in an analog transmission, and in megabits/second (Mbps) for digital transmission.

Bit
Binary digit. This is the smallest piece of digital information that a computer handles. This system limits this information to an 'on' or 'off', represented by a 0 or 1. All characters, numbers and symbols are translated into electronic strings of bits.

Bps
Bits per second
The number of binary digits transmitted per second. This transmission particularly applies to a modem. Common modems transmit at either 14.4 Kbps (14,400 bps) or 28.8 Kbps (28,000 bps), but newer modems are capable of 33.6 Kbps and 56Kbps, and in some cases, transmission speed may extend to 128 Kbps.

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† has been taken from the website Telehealth Net http://www.telehealth.net/glossary.html and it was compiled by Moheu, Malene M. And Alliance.

Broadband
A telecommunications medium composed of a bandwidth high enough to transmit high-quality voice transmissions and a wide band of frequency. Television, microwave, and satellite transmission are all example of this medium.

Browser
Also known as a Web browser. Any program that permits access and searches on the World Wide Web.

Byte
A string or cluster of eight bits to represent a character.

CCITT
Consultative Committee on International Telephone and Telegraph
Currently, the International Telecommunications Union Consultative Committee for Telecommunications (ITU-T). An international agency responsible for developing standards for telecommunications, as well as FAX and video coder-decoder (CODEC) devices.

CD-ROM
Compact Disk, Read Only Memory
A device used for storing large amounts of information, the equivalent of about 220,000 pages of text.

CDS
Clinical Decision Support
Information regarding a patient, his or her health problems, and alternative tests/treatments used to aid a clinician in diagnosis and treatment. Also referred to as Clinical Decision Support Systems (CDSS).

CEN
European Technical Committee for Normalization
An international agency responsible for setting standards in health care informatics.

Channel
A radio frequency assignment designed depending on the frequency band being used and the geographic location of the sending/receiving sites.

CHIN
Community Health Information Network
A popular system of communication created for common use by health professionals, patients and the community. This system fuses hospital information systems (HIS) with medical databases, community health information, and on-line computer services.

Clinical Information System
Relating exclusively to the information regarding the care of a patient, rather than administrative data, this hospital-based information system is designed to collect and organize data.

Closed
Refers to a type of mailing list that allows only members of that mailing list to send messages to it. Distinctive from 'open' or 'moderated'.

CMHCs
Community Mental Health Centers

Co-processor
A device within a computer to which specific processing operations are assigned, like mathematical computation or video display. This device accelerates processing speed significantly.

CODEC
Coder-Decoder
A device that converts a digital signal to an analog signal at one end of transmission, and back again to a digital signal at the opposing end.

Compatibility
Refers to the ability of two pieces of hardware (a personal computer and a printer, for example) to work together. Standards, published specifications of procedures, equipment interfaces, and data formats are essential to decreasing and possibly eventually extinguishing incompatibility.

Compression Ratio
The ration of the number of bits in an original image to the number in a compressed version of that image. For example, a compression ratio of 3:1 would signify a compressed image with a third of the number of bits of the original image.

Compressed Video
Video images that have been processed to reduce the amount of bandwidth adequate for capturing the necessary information so that the information can be sent over a telephone network.

Computed Radiography (CR)
A system of creating digital radiographic images that utilizes a storage phosphor plate (instead of film) in a cassette. Once the plate is exposed, a laser beam scans it to produce the digital data which are then translated to an image.

Computer Conferencing
Communications within groups through computers, or the use of shared computer

files, remote terminal equipment, and telecommunications channels for two-way communication.

Conference
Multiple public messages found on a system, usually specific to a particular topic and sometimes moderated by a conference host who leads the discussion. Also called "Folder," "SIG" (Special Interest Group), or "Echo." Very much like the newsgroups on the Internet.

Connectivity
The ability to send and receive information between two locations, devices, or business services.

CPR
Computerize Patient Record
A record, in electronic form, that is comprised of individual patient information that resides in a system capable of providing access to complete and accurate patient data, alerts, reminders, clinical decision support systems, links to medical knowledge, and other aids.

Data Compression
Method to reduce sheer volume of data by more efficient encoding practices, thereby reducing image processing, transmission times, bandwidth requirements, and storage space requirements. Some compression techniques result in the loss of some information, which may or may not be clinically important.

DDS
Digital Data System
A system for transmitting telephone traffic in digital format between major switching hubs. This system allows digital transmission of voice and data as a component of the analog telephone system (POTS).

Dedicated Line
A permanent telephone line reserved exclusively for one patient, accessible all hours of the day. These lines usually offer better quality than standard telephone lines, but may not significantly augment the performance of data communications. May also be known as "leased," or "private" lines.

DICOM
Digital Imaging and Communications in Medicine
A set of protocols describing how radiology images are identified and formatted that is vendor-independent and developed by the American College of Radiology and the National Electronic Manufacturers Association. The standard emphasizes point-to point connection of digital medical imaging devices. DICOM 3.0 is the current version.

Digital
Used in both electronic and light-based systems, these signals transmit audio, video, and data as bits. Digital technology allows communications signals to be compressed for transmissions that are more efficient.

Digital Camera
An image producing lens system made up of one or more light-sensitive integrated circuits, a myriad of light sensitive elements, and circuits for timing, nonlinear amplification, and encoding color.

Digital Image
An image formed by independent pixels, each of which is characterized by a digitally represented luminance level. For example, a popular screen size for digital images is a 1024 by 1024 matrix of pixels x 8 bits, representing 256 luminance levels.

Digital Signal
An electrical signal in the form of discrete voltage pulses. These signals transmit audio, video, and data as bits, which are either on or off, differing from analog signals, which are continuously varying. Communications signals may be compressed using digital technology, allowing efficient and reliable transmission rotes.

Digitize
The process by which analog, or continuous, information is transformed into digital, or discrete, information. Because most computers are only capable of processing digital information and visual information is inherently in analog format, this process is essential in computer imaging applications.

Direct Capture
A procedure by which image data are formed directly from the original source allowing a high quality image reproduction. In this process, images created from image files are identical to the original, regardless of the device used to capture them, such as a CT or an MRI. In direct video capture, the video signal is digitized from the display, which creates a higher quality image and is more efficient than acquisition through scanning.

Dish
An antenna shaped like a parabola that is the essential component of a satellite earth station, or downlink.

Domain
The last two parts of an e-mail address or an URL signifying an organizations name on the Internet. For example, "aol.com" refers to America OnLine.

Download
The process of transferring files or software from another computer to your computer.

Dpi
Dots per inch
The number of dots or pixels per inch used in film resolution. In conventional radiography resolution is given in line pairs per millimeter (lp/mm).

Duplex
A transmission system permitting data to be transmitted in both directions simultaneously.

Earth Station
The ground equipment essential for receiving and/or transmitting satellite telecommunications signals.

Email
An electronic system of transmitting messages through a computer system. Data can be transmitting to anywhere in the world for the price of a local telephone call. An email address is typically made up of a part of your name (your account name), the "at" sign (@), and your domain name.

Encryption
A system of encoding data on a Web page or e-mail where the information can only be retrieved and decoded by the person or computer system authorized to access it. Often used on the web to protect financial data.

Ethernet
A communications protocol that utilizes various types of cable at a rate of 10 Mbps.

Equal Access
The ability to choose between various long distance carriers. However, in more remote areas, some local exchange carriers are still serviced by only one long distance carrier.

FAQ
Frequently Asked Questions
A file developed for many public discussion groups that consist of popular questions and their answers.

Fiber Optic Cable
Cable that is insulated, flexible and consists of a glass core that relies on light sources rather than electricity to transmit audio, video, and data signals. This system permits high capacity transmission at extreme speeds, sometimes billions of bits per second, with very low error rates.

Firewall
Computer hardware and software designed to prevent unauthorized communications between an institution's computer network and external networks.

Frame
Also known as "framed." A Web sight with this characteristic is one that divides your Web browser's screen into smaller sections. Each area displays different data, usually to help the user navigate the Web sight, or to display advertisements.

FTP
File transfer protocol
The typical process for transferring files over the Internet or the software program that uses this procedure. Using this program, the user is permitted to connect to another computer online to transfer files to his/her desktop computer using a GET command. An "anonymous" ftp is usually allowed, where the user would enter "anonymous" as the login name, and his/her e-mail address as the password, enabling the user to access a limited number of public directories where files can be retrieved.

Full duplex
A channel used for communication that is capable of both transmitting and receiving in two directions at the same time. A standard telephone line is one example of this because both parties can simultaneously speak while listening to the voice on the opposing end.

Gateway
A computer used to provide translations between different types of standards. Generally refers to computers that translate complex protocol suites; for example, different E-mail messaging systems. Currently, it has been used to describe a "door" from a private data network to the Internet.

Gbps
Gigabits per second
A measure of bandwidth and rate of data flow in digital transmission.

Gb
Gigabyte
A measure of the storage capacity and memory of a computer. One gigabyte is equivalent to 1.074 billion bytes or 1,000 Mb. Usually used to express a data transfer rate, (1 gigabit/second=1 Gbps). The bandwidth of optical fiber is often in the gigabit or billion-bits-per second range.

Ghz
Gigahertz
One billion cycles per second. It measures analog signal transmission.

GIF
Graphical Interface Format
A typical graphics or image file commonly used on the Web that is most effective when the graphic or image is not a photograph.

GUI
Graphical User Interface
A method of controlling computers using graphic images or icons, to which the user accesses using a mouse.

Half Duplex
A channel of communication which is capable of both transmitting and receiving information, but only in one direction at a time.

Hard Drive
The storage device within a computer used to save data, files, and programs.

Hardware
Used to refer to all the tangible equipment related to information technology, including the computers, peripheral devices, such as printers, disks, and scanners, and the cables, switches, and other components of the telecommunications infrastructure that binds everything together.

HDTV
High-definition television
A television system with 1125 lines of horizontal resolution, with the ability of creating high quality video images.

HIS
Hospital Information System
Used to store and retrieve patient information, this integrated computer-based system may include or be linked to laboratory and radiology information systems (LIS and RIS).

HTML
Hypertext Markup Language
The guides to publishing used on WWW pages. It defines the events when the user clicks on a hypertext link embedded in the page. HTML is a publishing standard, not a programming language. HTML document comprise the core of a Web site, and can be identified by an .html or .htm suffix.

HTTP
Hypertext Transport Protocol
The standard by which the World Wide Web operates.

Image Processing
Process of modifying data representing an image, typically to ameliorate diagnostic interpretation, using algorithms.

Image Technology
The component of computer applications that transform documents, illustrations, photographs, and other images into data that computers and special-purpose workstations are capable of storing, distributing, accessing, and processing.

Independent Telephone Company
A local exchange carrier that is independent of the Bell system of operating companies (BOCs). In rural locations, many of the independent telephone companies are cooperative.

Informatics
The use of computer science and information technologies to the management and processing of data, information and knowledge.

Integrated Circuit
A solid state microcircuit comprised of interconnected semiconductor components diffused into a single instrument.

Interface
The connection between two devices; applies to both hardware and software.

Internet
The most formidable global network of business and personal computers connected through regular and high-speed telephone lines. It needs specific types of software to access it, such as a Web browser. It links computers and computer networks from colleges and universities, government agencies, institutions, and commercial organizations worldwide.

Internet Protocol
Based on the Web site's technical address, this is another way for accessing Web sites. The formal for this protocol is a four-part number, such as 207.87.223.39.

ISDN
Integrated Services Digital Network
A completely digital telephone system that is slowly enjoying more popularity throughout the United States which permits the integrated transmission of voice, video, and data to users at a higher speed than would be possible over typical telephone lines. It also provides connections to a universal network. It currently requires special installation and equipment.

ISO
International Organization for Standardization
Comprised of national bodies elected to set standards, this non-treaty organization is involved in illustrating norms for all communications fields except electrotechnical.

IT
Information Technology
Using a variety of techniques, it refers to the storage, manipulation, and communication of information in audio, data, and video formats.

ITU
International Telecommunications Union
This union, governed by a treaty and comprised of government telecommunications agencies, is responsible for setting standards for radio, telegraph, telephone, and television.

Java, Javascript
Two independent, but related programming languages that are largely Web-based. They permit augmented functionality of and enhancements to a Web site. If one's browser is unable to use these languages, the enhancements or features found in the Web site will usually not be displayed. Netscape and Microsoft support both types of languages.

JPEG
Joint Photographic Experts Group
An algorithm and standard for compressing digital photographic images. Related to GIF.

Kb
Kilobyte
A measure of computer storage and memory capacity. Equivalent to 1,024 bytes; often applied to 1,000 bytes as well.

Kbps
Kilobits per second
A measure of bandwidth and rate of data flow in digital transmission. One Kbps is 1,024 kilobits per second.

LAN
Local Area Network
A network of computers, generally small in number, whose reach is limited, typically within a building or campus, linked to allow access and sharing of data and computer resources by users. Differentiated from MAN and WAN by the size of the area, LAN is the smallest.

LDC
Long Distance Carrier
Also referred to as Interexchange Carrier (IEC).

Leased Lines
A line rented from a telephone company by a customer so that s/he may have exclusive rights to it. May also be called a dedicated line.

LEC
Local Exchange Carrier
A telephone company that carries local calls.

Mb
Megabyte
A measure of computer storage and memory capacity. One Mb is equivalent to 1.024 million bytes, 1,024 thousand bytes, or 1.024 kbs. However, this term is also applied to the more rounded term of 1 million bytes.

Mbps
Megabits per second
A measure of bandwidth and rate of data flow in digital transmission. One Mbps is equivalent to one million bits per second.

MCU
Multipoint Control Unit
Offered by switched network providers, this centrally located service allows three or more user to be connected, allowing audio and video teleconferencing.

Mhz
Megahertz
A measure of bandwidth and rate of information flow for analog transmission. One Mhz equals 10 to the sixth power cycles per second.

Microwave Link
A system of communication using high frequency radio signals, exceeding 800 megahertz, for audio, video, and data transmission. These links require line of sight connection between transmission antennas.

Mirror.
A Web site identical to another Web site at a different physical location. This process is typically used to expedite access because the original site resides on another continent. For example, a Web site may be set up in America duplicating an already existing Web site in Europe so that Americans can quickly access the site.

Modem
Modulator/De-modulator
A device that translates digital signals to pulse tone (analog) signals to enable transmission over telephone lines and reconverts them to digital form at the point of reception, thus permitting a computer to communicate with another computer over a

regular telephone line. These devices are usually identified by the speed (in bits per second or bps) of communication they permit. The higher the bps, the faster the modem.

Multimedia
A term which broadly applies to the transmission and manipulation of any form of information, including words, pictures, videos, music, numbers, or handwriting. This information is regarded as simply digital bits-zeroes and ones-as it is to a digital telecommunications link that carries information in bit form. The substantial increase in computing power permits integrated patient records with audio and video clips.

NetPhone
Commonly referred to as the "Internet telephone." Refers to the equipment used to permit two users to talk to one another using the Internet as the connection.

Network
A set of nodes, points or locations which are connected via data, voice, and video communications for the purpose of exchanging information.

Network
Interconnected telecommunications equipment used for data and information exchange. Consists of different types, LAN, MAN, and, WAN being examples.

Node
A branching or exchange point for networks.

OCR
Optical Character Recognition
Automatic scanning the translation of printed characters to computer-based text.

Operating System
The underlying system software which enables a computer to operate. Common operating systems include DOS, Windows, and Macintosh System 7x.

Operator
A character used to limit or broaden a search. Operators such as and, or, and not are referred to as a "Boolean operator.”

Optical Disk
A computer storage disk used solely for large quantities (Gbs) of data.

Packet
A basic message unit for communications in networks. A short block of data comprised of data, call control signals and error control information and containing information on its source, content and destination that is transferred in a packet switched network.

Packet Network
A network that gives out data bits in packets.

Packet Switching Network
May also be known as the Packet Switched Network (PSN). This term refers to the transmission of digital information using addressed packets that are transmitted along various routes in a network. This system is more efficient than modem transmission where the channel is occupied throughout the transmission, because the occupation in the channel is limited to packet transmission.

Packet Switching
The procedure of transmitting digital information via an addressed packets so that a channel is occupied only during the transmission of the packet.

PBX
Private Branch Exchange
A computerized private telephone switchboard with an extended scope of data and voice services. This exchange generally serves one organization and is connected to the public telephone network.

PDF
Portable Document Format
Permits the user to read a document and print it out using Adobe's Acrobat reader, a free piece of software. PDF files may only be read or printed using this software.

Peripheral
Any device that is attached to a computer externally. Scanners, mouse pointers, printers, keyboards, and monitors are all examples of this.

PET
Position Emission Tomography
Phosphor. The coating on the inside of a cathode ray tube (CRT) or monitor that produces light when hit by an electron beam.
Pixel
Stands for picture element. This is the smallest piece of information that a CRT is able to display, and is symbolized by a numerical code in the computer. Pixels appear on the monitor as dots of a specific color or intensity. There are many, many pixels in a single image.

Protocol
A system of guidelines and procedures, applying to both hardware and software, that oversees communications between two computer devices. They are primarily concerned with three aspects of the communication process: how data are symbolized and coded, how data are transmitted, and, in file transfer protocol, how errors and failures are recognized and corrected.

PSTN
Public Switched Telephone Network
The public telephone network.

RAM
Random Access Memory
The temporary memory area on a computer that permits the user to run software, process images, and store information. The amount of RAM needed varies according to the application. Increasing the amount of RAM in a computer can improve computer performance. Information stored in the RAM is lost when the power is shut off.

RANs
Rural Area Networks Shared-usage networks
Designed to include a wide scope of users in rural communities, such as educational, health, and business entities.

Real Time
The capture, processing, and presentation of data, audio, and/or video signals at the time the data is originated on one end and received at the other end. When signals are received at rates of 30 frames per second, real time is achieved.
Repeater
A bi-directional instrument used to amplify or regenerate signals.

Resolution
Refers to the ability of a device to distinguish between various factors. For example, spatial resolution is the ability to distinguish between adjacent structures. Contrast resolution is the ability to discriminate between shades of gray.

RIS
Radiology Information System. A synthesized system for the electronic processing, storage and transmission of radiographic images. RIS allows the remote interpretation of radiographic image-teleradiology-and may be connected to Hospital Information Systems (HIS) and Laboratory Information Systems (LIS).

ROM
Read Only Memory
The permanent memory capacity for a computer. programs and information stored in ROM are not lost when power is extinguished.

Routing
The assignment of a path of communication.

RTF
Rich Text Format
A series of word processing directions that are able to be read by the majority of word processing programs in order to retain the formatting rules of the document.

SAF
Store and Forward
A telemedicine interaction type that creates a multimedia electronic medical record. Data and images are captured and stored for later transmission, consultation or downloading. These static images or audio-video clips may be transmitted to a remote data storage device, from which they may be retrieved by a medical practitioner for review and consultation at any time, obviating the necessity of simultaneous availability of the consulting parties and reducing transmission costs due to low bandwidth requirements.

Satellite
An electronic retransmission instrument serving as a repeater, which is a bi-directional device used to amplify or regenerate signals, placed in orbit around the earth in geostationary orbit for the purpose of receiving and retransmitting electromagnetic signals. It typically receives signals from a single source and retransmits them over a wide geographic area, known as the satellite's "footprint."

Satellite Connections
A system of communications that uses radio signals sent to and from a satellite orbiting the Earth. The benefits of this mode of communication are that it allows connection between points at a great distance from each other on the Earth's surface, between which direct transmission is difficult, as well as to remote areas that lack cables for telephone lines.

SCSI
Small Computer Systems Interface
An interface system of rules and procedures used to connect peripherals such as disk drives, scanners, and tape back-up units, to computers. SCSI is also referred to as "scuzzy."

SDM
Shared Decision Making
A style of decision-making in health care where the patient is able to take a more active role in decision making, especially by offering them increased control over the choice of treatment, and, as a result, giving them a greater sense of responsibility for their care and health. Also called SDP, or Shared Decision Programs.

Search Engine
A Web site that indexes an online resource and makes that index available to other users for searching. This term is typically applied to a site that has indexed Web

documents, but search engines also index mailing lists and other online resources. An "internal" search engine index only includes the documents of that particular Web site, which permits the user to find information on that site more easily and quickly.

Server
A computer designated to providing specific services to other computers. For example, print servers only accept, store, and print out documents sent to them by other computers, and nothing else. Web servers permit users from around the world to access the Web sites and documents stored on them.

Shareware
Computer software that the author gives license to the user to "try before you buy." Users are encourages to try the software, copy it and distribute it to other users. If the user continues to use the software after the initial sampling, a voluntary payment of a specific sum of money is required. Failure to pay the requested fee is a legal violation of the author's copyright.

Site
An area or location online, typically on the Web, where an organization, individual or business stores its information.

SLIP
Serial Line Internet Protocol
A kind of computer protocol used by modems for online communication.

SONET
Synchronous Optical Networks
A broadband, wide area communications service capable of transmitting extremely high capacity data, such as interactive video, at very high speeds ranging from 150 Mbps to 10 Gbps. SONET services are convenient for real-time digital telemedicine applications.

Spam
Messages which are topic irrelevant usually taking the form of advertisements and are sent to wide variety of discussion forums (mailing lists or newsgroups), or e-mail addresses online. This practice, known as "spamming" is discouraged in the online world.

Spatial Resolution
Characteristic of being able to distinguish two equal sized adjacent objects in the same place. Represents the number of pixels in a specified area of a matrix.

Standards
Agreements on how to implement technologies.

Structured Data Entry
A method of data collection that constrains the content and format of clinical descriptions for the purpose of ensuring consistent, unambiguous, interchangeable messages.

Switch
A mechanical or solid state device that opens or closes circuits, varies operating parameters, or chooses paths or circuits on a space or time division basis.

Switched Line
Communication link for which the physical path, established through dialing, may change with each use.

Switched Network
A system of telecommunications where each user has a separate address and any two points can be linked directly, using any combination of available routes in the network.

Switched Service
A telecommunications service, often based on telephone technology, that switches circuits to connect multiple points.

Synchronous Transmission
The method by which bits are transmitted at a fixed rate with the transmitter and receiver synchronized, extinguishing the need for start/stop elements, with the result of providing increased efficiency.

Tariffs
Price guidelines for communication facilities, governed by federal or local governments, intended to permit telephone companies (LATA, see local access transport area) a fair rate of return on their capital investments.

TCP/IP
Transmission Control Protocol/Internet Protocol
The underlying communications rules and procedures that allow computers to interact with each other on the Internet.

Telecommunications
The use of wire, radio, visual, or other electromagnetic channels to transmit or receive signals for voice, data , and video communications.

Teleconferencing
Interactive electronic communication between multiple users at two or more sites which facilitates voice, video, and/or data transmission systems: audio, audiographics, computer and video systems.

Teleconsultation
The physical separation between multiple providers during a consultation.

Telediagnosis
The detection of a disease as a result of evaluating data transmitted to a receiving station from instruments monitoring a remote patient.

Telehealth
The use of electronic communications networks for the transmission of information and data focused on health promotion, disease prevention, diagnosis, consultation, education, and/or therapy, and the public's overall health including patient/community education and information, population-based data collection and management, and linkages for health care resources and referrals. Although telehealth is sometimes considered broader in scope than telemedicine, there is no clear-cut distinction between the two.

Telematics
The use of information processing based on a computer in telecommunications, and the use of telecommunications to permit computers to transfer programs and data to one another.

Telemedicine
The use of audio, video, and other telecommunications and electronic information processing technologies for the transmission of information and data relevant to the diagnosis and treatment of medical conditions, or to provide health services or aid health care personnel at distant sites.

Telementoring
The use of audio, video, and other telecommunications and electronic information processing technologies to provide individual guidance or direction. An example of this help may involve a consultant aiding a distant clinician in a new medical procedure.

Telemetry
The science and technology of automatic measurement and transmission of data via wires, radios, or another medium from stations based in remote locations to receiving stations for recording and analysis.

Telemonitoring
The process of using audio, video, and other telecommunications and electronic information processing technologies to monitor the health status of a patience from a distance.

Telepresence
The method of using robotic and other instruments that permit a clinician to perform a

procedure at a remote location by manipulating devices and receiving feedback or sensory information that contributes to a sense of being present at the remote site and allows a satisfactory degree of technical achievement. For example, this term could be applied to a surgeon using lasers or dental handpieces and receiving pressure similar to that created by touching a patient so that it seems as though s/he is actually present, permitting a satisfactory degree of dexterity.

Teletext
A broadcasting service utilizing several otherwise unused scanning lines (vertical blanking intervals) between frames of TV pictures to send data from a central database to receiving television sets.

Telnet
An application program that permits users to logon to any computer on the Internet for interaction with other users. For example, a telnet program may be used to peruse library holdings and receive results.

Terrestrial Carrier
A telecommunication transmission system using land-based facilities such as microwave towers, telephone lines, coaxial cable, or fiber optic cable as differentiated from satellite transmission.

Thread
Messages on an individual topic that appear in the order they were sent in an online discussion forum, such as on a newsgroup. This system makes reading of a particular subject easier, because all of the relevant messages are grouped together.

Throughput
The amount of data that is actually transmitted over a network in a given period of time, expressed in bits per second. Throughput rates are related to baud rates, but are generally little lower due to imperfect transmission conditions. Usually, higher baud rates will permit higher throughput.

Tie Line
A telephone circuit leased or dedicated to an individual which is provided by common carriers that connect two points together without using the switched telephone network.

Translator
A broadband network operation. A translator is an instrument, located in a central retransmission facility to filter incoming microwave signals and retransmit them in a higher frequency band.

Transmission Speed
The speed at which information passes over a communications channel; generally

given in either bits per second (bps) or baud.

Transponder
A microwave receiver and transmitter in a satellite that receives signals being transmitted from Earth, amplifies them, and sends them back down to Earth for reception purposes.

Turn-key System
A system of telecommunications in which all of the installation services and components needed for operational teleconferencing have been provided by a single vendor or contractor.

Uplink
The link, or path, from a transmitting earth station to the satellite. The term is typically referring to a transmitting earth station.

Upload
Transferring files or software from one computer to another.

URL
Uniform Resource Locator
The standard form for an address on the Internet. For example, http://www.vase.org/ indicates a Hypertext Transport Protocol (http) address on the World Wide Web (www) with location "vase" and the type of owner (org). Other valid guidelines may include ftp and gopher. Unlike most e-mail addresses, URLs are always case sensitive, that is, whether a character is upper or lower case does make a difference.

User Interface
The graphic and design components of a Web page that directs users on how to access the information contained in that Web site.

Videoconferencing
Actual-time, generally two way transmission of digitized video images between multiple locations; uses telecommunications to bring people at physically remote locations together for meetings. Each individual location in a videoconferencing system requires a room equipped to send and receive video.

Virtual Circuit
Packet switched network facilities that appear to be an actual end-to-end circuit.

Virtual Reality
A computer-based technology for simulating visual, auditory, and other sensory aspects of complex environments to create an illusion of being a three-dimensional world. That world is designed by the computer, and viewed through a special headset that responds to your head movements while a glove responds to your hand

movements. For example, while in a virtual room you may move your hand up in order to fly or tap to change the color of a wall.

Voice Recognition
The ability of a computer to interpret auditory information in the form of spoken words.

Voice Switching
An electronic method for opening and closing a circuit, such as changing form one microphone to another microphone or from one video camera to another video camera, responding to the presence or absence of sound.

Wildcard
Typically represented by an asterisk (*), a wildcard symbol permits the user to conduct an open-ended search. It may be used to ensure a search turns up all forms or derivatives of a word. For example, chil* will turn up both child and children.

WWW
World Wide Web
Also known as "the Web." An Internet information resource for international hypertext linking which offers graphics, sound, text, and in some cases video clips giving information. This is the newest (1993) and fastest growing aspect of the Internet because of its ability to offer more than just plain text online.