# Telemedicine and the Transformation of Healthcare Practice in the Information Age

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Telecommunications and informatics technologies applied to the health sector are critical for attaining the goal of improving access to equitable healthcare and the practice of evidence-based quality health interventions, for the cost-efficient operation and management of health services and health programs, and for the provision of individualized healthcare. Healthcare organization and delivery are undergoing a shift from an institution-centered to a citizen-centered model. The prime feature of the model is a new emphasis on continuity of services supporting health promotion and maintenance. It encompasses informed citizens caring for their health and an assortment of stakeholders responsible for the delivery of a continuum of health services within a region. The variety of environments, priorities, organization, and operational demands of the healthcare sector require Telemedicine applications and technologies capable of providing support for the challenging and complex interdependent clinical, public health, and managerial decisions and interventions that characterize health practice.

## 1. Introduction

Telemedicine applications comprise a broad and expanding domain that use the resources of interactive communication technologies. Telemedicine combines the use of telecommunications, computer technologies, and informatics – the applied science of collecting, storing, and retrieving data to support informed decision making – to improve the effectiveness and efficiency of healthcare. It liberates caregivers from the traditional constraints of place and time, empowers individuals to make informed choices, and changes the way health practice is conducted in a competitive marketplace. Although the use of telecommunications in healthcare dates back to the early '50s experiences in the United States and Canada, especially with the Arizona Papago Indian Reservation Project (NASA/Lockheed) and the Dartmouth Medical School link of a New Hampshire teaching hospital with outlying rural clinics, the term only became of common usage in the early '90s.

Cybermedicine and Telehealth are other terms frequently used for this application domain. They are not necessarily synonymous with Telemedicine – although the technologies involved are basically the same, the ends are somewhat different. Telemedicine is most frequently used to describe care-related applications while Telehealth encompasses other functions such as education and training, health promotion, public health, health services management, technical information retrieval, etc. Cybermedicine, more properly refers to the intersection of health and bioengineering, implantable intelligent hardware, automation of processes, robotics, biosensors, nanotechnology, etc. In the context of this paper we will used the term Telemedicine in its broadest possible scope including functions and applications of both Telehealth and Cybermedicine.

Interactive communication technologies are shaping the future of healthcare and Telemedicine solutions. They reinforce, complement, and enhance existing health programs and healthcare delivery systems, offer new solutions for health interventions, and create the opportunity for the establishment and operation of innovative practice models. Telemedicine is not happening in isolation but is closely linked – although lagging behind – to similar developments in commercial, education, entertainment, and industrial areas. Areas of application include: consultation services and remote care; clinical, epidemiological, and administrative data management and communication; provision of diagnostic and

therapeutic services; image-based systems; integration of distributed providers; access to knowledge databases and decision support tools; education and training through interactive communication media; health promotion; and the management of physical and financial resources.

## 2. Telemedicine in the Context of Health Systems

The health sector of every country is facing the need to provide expanded and equitable access to quality healthcare services and to reduce, or at least control, the rising costs of healthcare services. There is a growing demand for additional high-cost services due to the aging of the population; changing epidemiological landscape; improvements in medical technology leading to more possibilities of diagnostic and therapeutic action; supply pressures from new and costly medical technologies; increasing expectations and demands of citizens for more and better services in terms of quality and accessibility; and a growing willingness to pay for health privately. At the same time, traditional revenue streams that have supported indigent care,

public health interventions, medical research, and professional education are insufficient or being reduced, forcing healthcare organizations to seek new methods to support those basic activities. New partnerships among healthcare providers and payers also require more and better clinical practice guidelines and outcomes information.

As response, healthcare organization and delivery is undergoing a shift from an institution-centered to a citizen-centered model. Most health sector reform initiatives have been grounded in the universalization of a high cost-benefit basic package of health services, a set of standardized public health interventions, cost containment and recovery, administrative decentralization and operation of healthcare services, and the recognition of the role of the private subsector and intersectorality of health interventions. The manner healthcare is provided involves the separation between organizations that provide, regulate, and finance health interventions. New roles are expected from users and providers with the incorporation of new professional categories, and increased local government responsibility in management and financing.
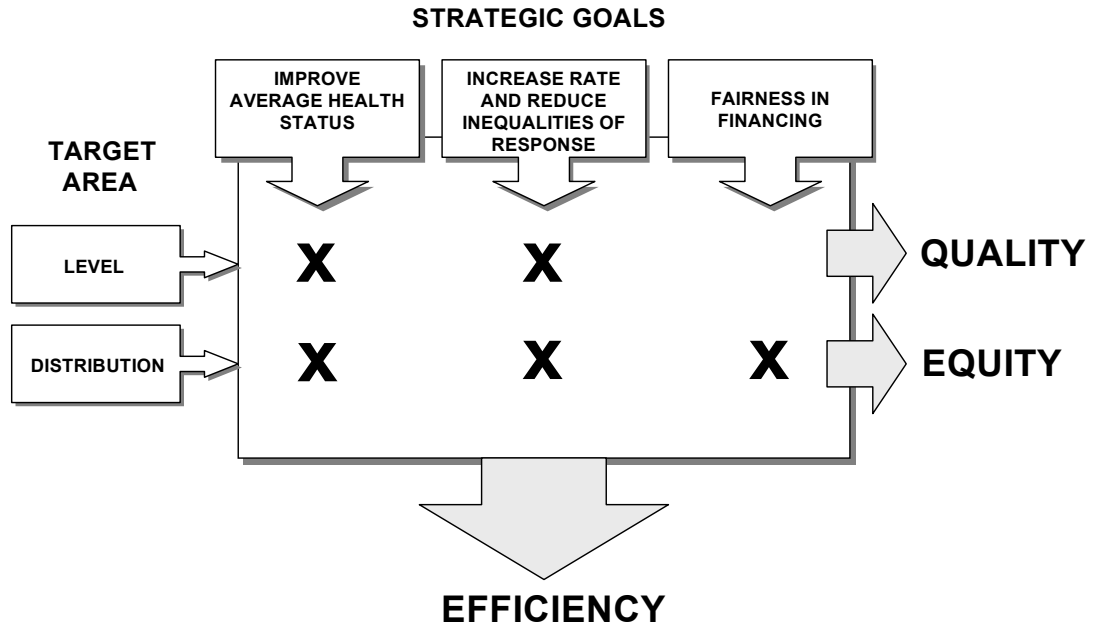


**Figure 1.** Quantitative, Qualitative, and Distributional Goals of Healthcare Systems

The new health models being discussed, designed, and implemented are oriented towards primary care; are centered on people; focused on quality, sound financing, and accountability; and stress explicitly defined targets for improved health status, better responsiveness, and fairness in financing, with the goal of achieving greater efficiency, quality, and equity in health interventions (Figure 1).

Its prime feature is a new emphasis on continuity of services supporting health promotion and maintenance. The new paradigm includes informed citizens caring for their health and stakeholders responsible for the provision and continuity of health services within a region.

This vision implies a decentralized health care where services with evidence-based effectiveness are accessible to all and provided in a way in which organizational boundaries are invisible to the citizen. In this environment, information and communication technologies role is to support information distribution and sharing between health promotion, primary health care, hospital services, rehabilitation, home care and other relevant service modalities.

This development has led to a global need for restructuring of the healthcare systems, with the objective of providing better value for the resources spent through better management. Reforms are also concerned with benefits in terms of "health gain". This involves a critical appraisal of medical knowledge for evaluating the effectiveness of medical interventions, supported by a growing effort in outcomes research.

Health organizations are already moving away from the reactive delivery of care to a more proactive management approach of the health status of individuals and population groups and their mission consider the perspective of the client and other social actors involved in the health intervention processes. In market economies, increasing competition, the merger of provider organizations, aggressive contracting by payers, and greater involvement of employer and government purchasers have characterized the changing process of health management.

In this new environment, information systems are essential and must be designed and implemented in an appropriate manner to be able to support the diversity of perspectives of regulators, managers, payers, providers, and clients. The information requirements of the health sector to support the new care model will require innovative approaches to

systems specifications; the integration of internal and external data and information; fast communication of clinical data of individual patients; access to clinical and administrative multi-institutional and integrated data; distributed provision of healthcare with concurrent usage; focus on the local operational level and point of service support; support of preventive care and health promotion; emphasis on managerial and professional decision-making and accountability; better clinical and administrative documentation; cost reduction and recovery; flexible and integrative design that integrates technologically different platforms; and tools for analysis, interpretation, and dissemination of data and information.

## 3. Telemedicine as the Agent of Transformation of Health Practice

Telemedicine potentialities are widely misunderstood – its long-term impact on healthcare is often confused by focus on limited applications, short-term policy and regulatory problems, implementation issues, and utopian expectations. The general perception and most accounts of Telemedicine applications have been highly tinted by its use in a physician-centric context or in a patient-doctor relationship without considering the broader context of providers and the multiplicity of other possible uses.

Another misperception is related to the idea that Telemedicine main functionality and value is to bridge barriers of distance – although it is clear that Telemedicine applications overcome the barrier of distance, it is generally not implicit that another significant contribution of Telemedicine is to bridge the barrier of time – there is a mistaken general assumption that the encounter provider-client is always held in real-time. In reality, Telemedicine creates a whole new range of possibilities by allowing providers and clients to interact using store and forward techniques, and thus liberating providers and clients from the need and constraint of synchronous encounters.

Telemedicine revolutionizes healthcare restructuring virtually every professional relationship and technical activity. Medical care in this new environment is evolving from the physician-centered model, as the sole responsible party in defining a medical problem and its care, to a new model of shared responsibilities where consumers, isolated or in groups make health-related decisions assisted by a variety of practitioners, sources of information, and decision-support tools. This empowerment of

consumers is perhaps the most dramatic change brought forth by interactive health communications

By nature, Telemedicine is an international experience. Notwithstanding protectionist trade and (Figure 2).

regulatory barriers erected to shelter national, regional, and economic entities, the Telemedicine revolution is determining dramatic changes without respect to international borders.
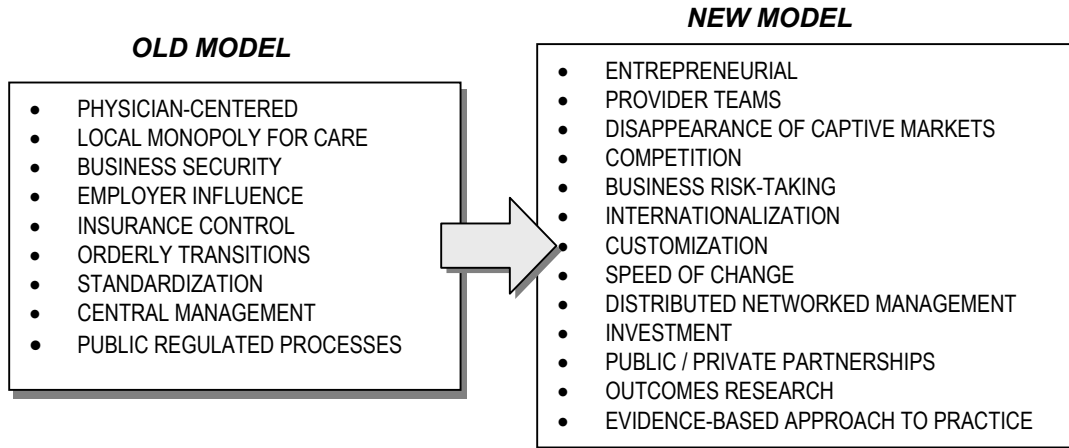
*OLD MODEL*

- PHYSICIAN-CENTERED
- LOCAL MONOPOLY FOR CARE
- BUSINESS SECURITY
- EMPLOYER INFLUENCE
- INSURANCE CONTROL
- ORDERLY TRANSITIONS
- STANDARDIZATION
- CENTRAL MANAGEMENT
- PUBLIC REGULATED PROCESSES

*NEW MODEL*

- ENTREPRENEURIAL
- PROVIDER TEAMS
- DISAPPEARANCE OF CAPTIVE MARKETS
- COMPETITION
- BUSINESS RISK-TAKING
- INTERNATIONALIZATION
- CUSTOMIZATION
- SPEED OF CHANGE
- DISTRIBUTED NETWORKED MANAGEMENT
- INVESTMENT
- PUBLIC / PRIVATE PARTNERSHIPS
- OUTCOMES RESEARCH
- EVIDENCE-BASED APPROACH TO PRACTICE

**Figure 2.** Paradigm Change of Healthcare Systems Resulting from the Introduction of Interactive Communication Technologies
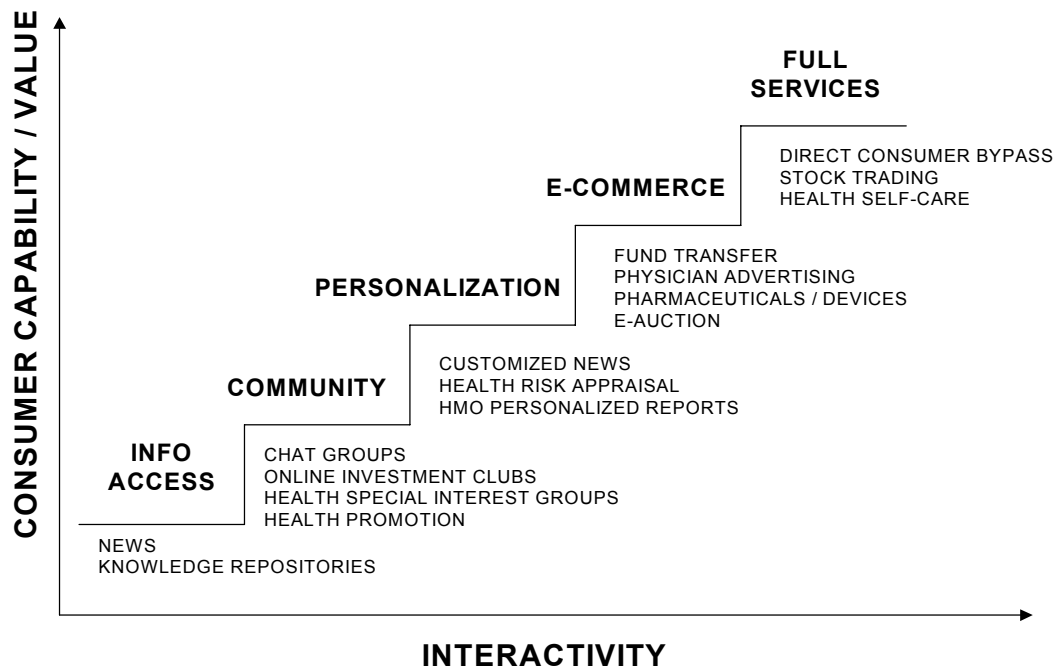


**Figure 3.** Progressive Capabilities and Interactivity of Telecommunication Applications in Health

The growing number of ways by which interactive communications can bring health information to the non-professional allows informed decisions by consumers and generates competition and new forms of organization and delivery of care characterized by increasing consumer capabilities and added value on interactive transactions (Figure 3). The economic impact of Telemedicine is enormous and is realized through better health care at lower cost at the microeconomic level, and increased competition at the macro level. The latter is determining a radical change in the traditional structure of the health professions and organizations – healthcare has been typically outside the market competition forces related to the purchasers' informed decision making, due to the constraints imposed by the mo-nopolistic control of knowledge by the health professionals.

## 4. Components of Telemedicine

Components necessary to ensure that health information and services are properly integrated with the telecommunications and information technologies are represented in Figure 4. The stepwise model emphasizes the critical requirements for the deployment of Telemedicine applications, progressing from health and informatics infrastructure to the establishment of a sustainable national and international market environment.
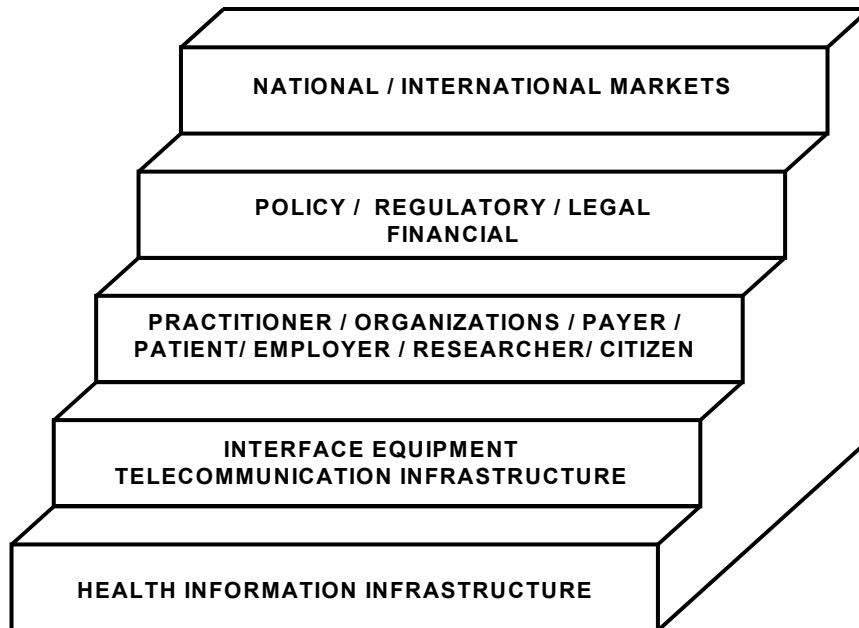


**Figure 4.** Systems Components of Telemedicine

The national health information infrastructure and the telecommunications and informatics infrastructure, including health applications interface equipment, represent a complex set of definitions, standards, technologies, and applications that support communication, information, and knowledge. Most of the information technologies that can be applied to the health sector are common across sectors or share common elements and, as the linkages between the national information infrastructure and the health information infrastructure are strengthened, solutions developed in sectors other than health will emerge and will be adapted to solve specific problems of the health sector. The user layer, represented by practitioners, organizations, clients, and other stakeholders, interact in a variety of intricate ways and determine the functionalities required, availability, and cost of systems. Important policy, regulatory, legal, and financial issues include standards for practice, licensing, liability, privacy, confidentiality, and reimbursement. Finally, market aspects include technology providers and regulators; services and solutions providers; business strategies; and market development cycle and product transfer issues.

## 5. Facilitating and Constraining Factors

A national health information infrastructure is an essential mechanism in promoting health and providing healthcare. However, in most cases it continues to be a largely incipient resource. The health sector has not applied the available information and telecommunication technologies as effectively as have other sectors and, when one considers the social importance of health, the sector has been conspicuously underrepresented in national technology development policies and plans of developing countries. Industrialized and developing countries have different facilitating and constraining factors although there is a significant set of constraining factors that are common to both (Figure 5).
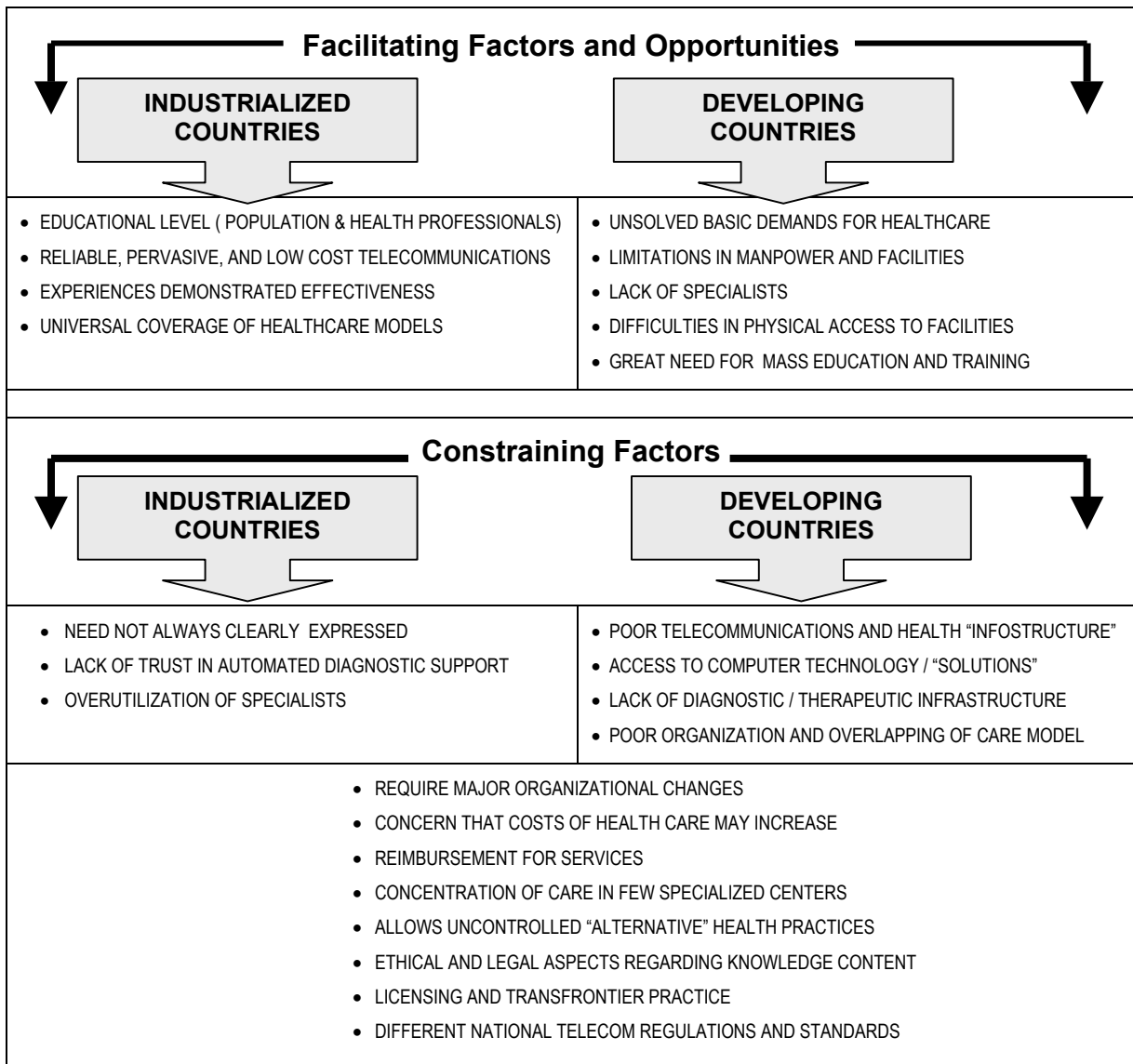
**Facilitating Factors and Opportunities**

**INDUSTRIALIZED COUNTRIES**

- EDUCATIONAL LEVEL ( POPULATION & HEALTH PROFESSIONALS)
- RELIABLE, PERVASIVE, AND LOW COST TELECOMMUNICATIONS
- EXPERIENCES DEMONSTRATED EFFECTIVENESS
- UNIVERSAL COVERAGE OF HEALTHCARE MODELS

**DEVELOPING COUNTRIES**

- UNSOLVED BASIC DEMANDS FOR HEALTHCARE
- LIMITATIONS IN MANPOWER AND FACILITIES
- LACK OF SPECIALISTS
- DIFFICULTIES IN PHYSICAL ACCESS TO FACILITIES
- GREAT NEED FOR MASS EDUCATION AND TRAINING

**Constraining Factors**

**INDUSTRIALIZED COUNTRIES**

- NEED NOT ALWAYS CLEARLY EXPRESSED
- LACK OF TRUST IN AUTOMATED DIAGNOSTIC SUPPORT
- OVERUTILIZATION OF SPECIALISTS

**DEVELOPING COUNTRIES**

- POOR TELECOMMUNICATIONS AND HEALTH "INFOSTRUCTURE"
- ACCESS TO COMPUTER TECHNOLOGY / "SOLUTIONS"
- LACK OF DIAGNOSTIC / THERAPEUTIC INFRASTRUCTURE
- POOR ORGANIZATION AND OVERLAPPING OF CARE MODEL

- REQUIRE MAJOR ORGANIZATIONAL CHANGES
- CONCERN THAT COSTS OF HEALTH CARE MAY INCREASE
- REIMBURSEMENT FOR SERVICES
- CONCENTRATION OF CARE IN FEW SPECIALIZED CENTERS
- ALLOWS UNCONTROLLED "ALTERNATIVE" HEALTH PRACTICES
- ETHICAL AND LEGAL ASPECTS REGARDING KNOWLEDGE CONTENT
- LICENSING AND TRANSFRONTIER PRACTICE
- DIFFERENT NATIONAL TELECOM REGULATIONS AND STANDARDS

**Figure 5.** Facilitating and Constraining Factors in the Deployment of Telemedicine Applications

## 6. Opportunities and Challenges

The Global Information Infrastructure (GII) is expanding at an exponential rate. Besides the well established areas of distant consultation, message switching, access to knowledge databases, integration of providers, service management, and the transmission of biological signals and still and moving medical images, telecommunication and informatics have opened a whole new range of possibilities. The health component of the GII creates opportunities that can dramatically improve the practice of knowledge-enhanced Telemedicine and the reengineering of national and international health systems; the creation of local, national, and global markets for the exchange of health products and services; decentralization of healthcare; improvement of health status; and the protection of the biodiversity of ecosystems. Because of early implementation stage, there is no firm data by which to estimate market potential, early prediction suggest a market opportunity as large as 100-200 billion for the U.S. alone. To developing countries or communities, the GII offers the potential for a quantum leap in health, quality of life, and functional life capacity.

One prime area where global linkage has the greatest potential is in distance learning. Continuing medical education transcends geographic or geopolitical isolation. Courseware is now being developed in hundreds of subject areas, in several languages, and directly applicable to international medicine and global education. It permits access to basic, intermediate, and advanced course work by physicians, technicians, nurses, and allied health workers who may substantially enhance their skills by utilizing that teaching modality.

Internet-based and other interactive communication technologies present opportunities to improve both personal and public health. A range of interactive media applications are being used to assess and reduce health risks, promote healthy behaviors, and provide information and decision support about health and medical choices. These technologies hold considerable promise in improving community and individual health status and in reducing healthcare costs. Another rapidly growing area within the field of clinical medicine is the increasing utilization of centralized telephone triage and health orientation systems (Consumer Call Centers) to assist in the after-hours coverage, to provide linkage to the primary care physician, and to provide emergency medical help. The service can be enhanced by the concomitant use of automated medi-

cal records system (Electronic Health Record or Computer-based Patient Medical Record).

Interactive health communication technologies applications include those that focus on promoting individual and community health, improving self-care, educating patients, and promoting healthy behaviors through provision and sharing of information and structured decision-making processes. The use of computers to facilitate the sharing of ideas and experiences with others in similar health-related situations not only results in better-informed consumers, but also may provide social benefits that have a great potential impact in health promotion and illness prevention. Individuals are increasingly turning to the Web and other electronic sources for health information, and thus becoming more knowledgeable consumers of healthcare. Searching for health information is one of the most common reasons for public use of the World Wide Web – a March 1999 survey by Schwarz Pharma showed that in the U.S. 33% of adult women and 24% of adult men use the Internet to get medical information. Another survey (Harris opinion poll, February 1999) revealed that 68% of online adults seek health information.

Interactive community information resources have been established to help community members become more effective consumers of healthcare services and, by providing timely expert answers to anonymously asked medical questions at no charge, that type of service has proved to decrease unnecessary physician-patient encounters, encourage effective preventive-health measures, and improve the overall results of healthcare in the community.

Telemedicine is a growing market with great potential but the identification of opportunities and market development proved to be a difficult process even in industrialized societies. Issues related to the building and maintenance of the technological infrastructure and the development of specific applications directed to clinical and health systems present a series of obstacles. Problems with systems specification in the health sector pose serious limitations to project design and development – they include: low definition level of contents (deliverables) of health interventions; indetermination of objectives and desired functionalities; lack of consensus regarding priorities; difficulties in having a coordinated approach to problem solving; conflicts in the definition of minimum data sets required for operational management and clinical decision making. Human and organizational constraints, common in nature

and import in every environment – developed and developing societies – are the most critical and difficult issues to address, when compared to technological obstacles. There are many challenges to deployment and the obstacles that must be faced and they are especially serious in developing nations:

### [a] Related Primarily to the Health Sector

- Complexity and variety of objectives, functions and technical contents of health applications and the difficulties of health professionals to systematically define requirements.

- Alignment of applications to institutional goals and expectations of users.

- Socioeconomic and cultural aspects, such as the role of caregivers, literacy of population, computer access and level of computer literacy of users.

- Lack of national policies, regulations, and legal framework, including barriers such as professional practice regulations and licensing. The time warp between the developers and users and regulators is the underlying cause for many discontinuities.

- Poor health Information infrastructure and experience with information project development.

- Non-standard medical data structures.

- Quality of health data including integrity and pertinence.

### [b] Related Primarily to Technological Issues

- Technological infrastructure including telecommunications and connectivity issues, especially when combined with deployment capability and investment sustainability.

- Limited agreement and diffusion of technical standards.

- Availability of telecommunications and country-specific policies and regulations.

- Security including issues related to data protection, authentication, access control, privacy, and confidentiality.

- Reliability of implemented systems, i.e., availability on demand.

- Cost of telecommunications, in special high international rates.

- Evaluation of experiences still incipient – large number of projects have been highly subsidized, making evaluation of impact and cost-benefit difficult.

## 7. A Model for Telemedicine Project Development

Telemedicine project and program development integrates technology, geography, culture, language and health systems and each specific application environment and project requires a tailored needs assessment study. Key to success is to be informed and open to new developments; clear specification of objectives and needs and only then proceed to select the technology; user-friendliness; open architecture; and basing investments on a "money saved" business plan. Early and continuous user involvement – aim is to empower people – is critical for fit and acceptance of final product and services. Most users prefer a carefully crafted partnership to a downright simple vendor-client relationship.

Although there is no single "cookbook" solution, develop or buy decisions should carefully consider advantages of off-the-shelf products, as opposed to development or customization and leasing versus capital outlay options. One can not emphasize enough the importance of well documented, cost-justified decisions when implementing Telemedicine systems and the benefits of user-defined and prioritized applications; critical analysis of costs; open communication between users and systems professionals and vendors; systematic procurement procedures; and rational contracting.

### 7.1. Goals

Correct, i.e., technically appropriate and feasible deployment of Telemedicine initiatives and applications signify that they must be inserted within the healthcare structure and based on objective assessment of need, clear purpose, cost-effectiveness, and integration with the overall national health policies and structures.

Selection and implementation of technologies and applications must contribute to social and economic development and the improvement of access to

health services, equity, and quality of care. Best-of-breed technologies are those that support evidence-based health practice; the technical effectiveness of collective and individual health interventions; professional education; health promotion; and managerial efficiency (Figure 6).

- TECHNICALLY APPROPRIATE AND FEASIBLE

- COST-EFFECTIVE

- CAN BE MAINTAINED WITH LOCAL SKILLS AND RESOURCES

- ACCEPTABLE BY CLIENTS AND PROVIDERS

- RESULT IN FAVORABLE EFFECTS ON HEALTH

**Figure 6.** Goals of Telemedicine Applications

### 7.2. Strategic and Tactical Approaches to Telemedicine Project Development

National priorities and capabilities will determine how, where, and when applications should be deployed and appropriateness of project design, development, and management are critical for ensuring success. The process of installing new systems is often difficult and requires tremendous discipline. Daily demands on personnel, changes in the market, and conflicts about running the healthcare services are all potential barriers to realization.

The installation of a new care model and technology is a tremendous undertaking for any organization, affecting every area of the operation. Often, because of time and budget constraints as well as the perception that change is not immediately necessary, many organizations wait until there is no other option but to carry out changes within short time frames and thus increasing the risks of failure. For a large, multisite organization the issues are the same, but the complexity increases tremendously.

While there is no "magic bullet" to make the transition easy, attention to a few basic guidelines will allow the organization the best chance of success:

- Right people, right training.

- Managed care is highly integrated and configuring or changing one module may affect the system in several other areas.

- Unified leadership throughout project design, development, and implementation.

- Stress on business goals, not systems goals.

- Strong and detailed project plan before embarking in service contracting and technology acquisition.

- The organization needed to maintain an integrated application environment is often ignored in light of more pressing installation decisions.

The Figure 7 summarizes the strategic and tactical approaches recommended for the development and deployment of Telemedicine applications.

### 7.3. Building Inter-Organizational Systems

Information systems have traditionally been developed for one organization. The objectives of the system have been stated by the organization, and the costs and incomes generated by the system have been addressable to that particular organization. Telemedicine involves new inter-organizational requirements for data and information processing and communication that causes many deviations from this relatively simple situation. Inter-organizational information systems are systems by which independent organizational units communicate by the means of data transfer from one computer to another.

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**Figure 7.** Strategic and Tactical Approaches for the Deployment of Telemedicine

Inter-organizational systems demand different management, systems development, and use practices from ordinary intra-organizational systems. The main points of difference are: they can not always be legitimated in the short run (the time period present in most conventional cost/benefit analyses) by the operational or strategic benefits they bring – these take time to occur; must be based on current systems, especially databases, telecommunication equipment, and standards; require great cooperative and communication skills of systems professionals; often need priority arrangements in initiation phases; and require heavy dedication in both the quality and intensity of use.

## Selected References

Allen, A. (1996). *The rise and fall and rise of telemedicine. In Telemedicine Sourcebook 1996-1997*. Faulkner & Gray's Healthcare Information Center, Faulkner & Gray, New York.

Balas, E.A.; Jaffrey, F.; Kuperman, G.J.; Boren, S.A.; Brown G.D.; Pinciroli, F. and Mitchell, J.A. (1997). *Electronic communication with patients: Evaluation of distance medicine technology*. JAMA 278(2):152-159.

Bashshur, R.; Puskin, D. and Silva, J. (Eds) (1995*). Telemedicine and the National Information Infrastructure*. Second Invitational Consensus Conference on Telemedicine and the National Information Infrastructure, Augusta, GA, May2-4. Telemedicine Journal vol 1 (4) 321-375.

Bauer, J.C. and Ringel, M.A. (1999). *Telemedicine and the Reinvention of Healthcare*. Healthcare Informatics Executive Management Series. McGraw-Hill. ISBN 0 07134630 9.

Bonder, S. and Zajtchuk, R. (1996). *Changing the Paradigm for Telemedicine Development and Evaluation: A Prospective Model-Based Approach. DoD Contract DASW01-95-D-0030*. Vector Research, Inc. And Department of Defense Telemedicine Test Bed Project, US Army Medical Research and Materiel Command.

Brender, J. (1998). *Methodology for constructive assessment of IT-based systems in an organizational context*. Paper presented at the International Medical Informatics Association WG13 and WG15 Working Conference, Feb 27-March 1, Helsinki. Available at http://www-vatam.unimaas.nl/imia/.

Caribbean Latin America Action (1997). *Telecommunications/Information Technology Recommendations: Moving Toward Free Trade for the Americas*. Paper prepared by the C/LAA Telecommunications Business Team for the Third Business Forum of the Americas and Trade Ministerial Meeting, Belo Horizonte, Brazil, May 13-16.

Cerda Montero, I. (1995). *Los sistemas de información (SI) y el proceso de desconcentración del sector salud*. Rev Cienc Admin Financ Segur Soc 3(1): 47-50.

Colby, M. (1996). *Telemedicine is poised to revolutionize the practice of medicine. In Telemedicine Sourcebook 1996-1997*. Faulkner & Gray's Healthcare Information Center, Faulkner & Gray, New York.

Commonwealth Secretariat (1997). *Telecommunications for Development in the Commonwealth. Report of a Workshop held in Malta 22-24 May, 1997*. Education Department, Human Resource Development Division, Commonwealth Secretariat, Marlborough House, London.

Council on Competitiveness (1996). *Highway to Health: Transforming U.S. Health Care in the Information Age.* Washington, DC, March.

Council on Competitiveness (1993). *Competition Policy: Unlocking the National Information Infrastructure.* Washington, DC, December.

Crawford, C.M. and HIAWG Work Group on Managed Care (1996). *Managed Care and the NII: A Public/Private Perspective. Final Report of the National Information Infrastructure Task Force*, Committee on Applications and Technology, Health Information and Applications Working Group. March, Washington, DC.

Dede C. and Fontana, L. (1995). *Transforming health education via new media*. In Harris, L. (Ed), *Health and the New Media*. Hillsdale, NJ: Lawrence Erlbaurn Associates, Inc., pg 163-184.

De Maeseneer, J. And Beolchi, L. (Eds) (1995). *Telematics in Primary Care in Europe*. Studies in Health Technology and Informatics Volume 20. IOS Press/Ohmsha, Amsterdam, ISBN 90 5199 209 2.

European Commission (1994). *Growth, Competitiveness, Employment - The Challenges and Ways Forward in to the 21st Century. White Paper*. Luxembourg, EC Publications Office, CM-82-94-529-EN-C Euro-OP, L-2985.

European Commission (1996*). TELMED - The Impact of Telematics on the Healthcare Sector in Europe. Final Report*. Prepared by The Tavistock Institute, the European Center for Work and Society and the Fondazione per la Ricerca sulla Migrazione e sulla Integrazione della Technologie. EU Commission Directorate DG XIII, November 1996. Available at www.ehto.be/ht_projects/telmed2.

Farmer, J.; Richardson, A.; Lawton, S.; Morrison, P. and Higgins, R. (1996). *Improving access to information for nursing staff in remote areas: the potential of the Internet and other networked information resources. Summary of Project Report*. School of Information and Media, Robert Gordon University, Aberdeen, UK . Published at http://www.rgu.ac.uk/~sim/research/irn/irn.htm.

Ferguson, E.W.; Doarn, C.R and Scott, J.C. (1995). *Survey of global telemedicine*. J Med Systems 19(1): 35-46.

Greenes, R.A and Bauman, R.A. (1996). *The era of health care reform and the information superhighway. Implications for radiology*. Radiol Clin North Am 34(3):463-468.

Grenade, P. (1996). *Telemedicine: A look at the legal issues confronting a new delivery system*. Kilpatrick & Cody Medical Law Update, Winter.

Grigsby, J. (1995). *Current status of domestic telemedicine*. J Med Systems, 19(1): 19-27.

Grigsby, J.; Kaehny, M.M.; Sandberg, E.J.; Schlenker, R.E. and Shaughnessy, P.W. (1995). *Effects and effectiveness of telemedicine*. Health Care Financing Review, Fall: 115-127.

IITF(1995). *Privacy and the NII: Safeguarding Telecommunications-Related Personal Information*. Report of the Information Infrastructure Task Force (IITF). National Telecommunications and Information Agency, U.S. Department of Commerce, Washington, DC, October.

Impicciatore, P.; Pandolfini, C.; Casella, N. and Bonatti, M. (1997). *Reliability of health information for the public on the World Wide Web: systematic survey of advice on managing fever in children at home*. BMJ 314:1875-1879.

International Medical Informatics Association (1993). *Health Informatics in Africa - HELINA 93. Proceedings of the First International Conference on Health Informatics in Africa*. Elsevier Science Publishers International Congress Series No. 1055 Amsterdam, ISBN 0 444 81 81752 2.

International Telecommunication Union (1996*). Telemedicine and Developing Countries. Report of the Study Group 2*, Geneva.

Institute of Medicine (1994). *Health data in the Information Age: Use, Disclosure, and Privacy.* Donaldson, M.D. and. Lohr, K.N. (Eds.). Washington, DC, National Academy Press.

Institute of Medicine (1996). *Telemedicine – A Guide to Assessing Telecommunications in Health Care*. Field, M.J. (Editor). Washington, DC, National Academic Press. ISBN 09 309 05531 8

Inter-American Development Bank (1998). *Investment Priorities for the Information Infrastructure in Latin America and the Caribbean*. A Report prepared by the Infrastructure and Policy Task Force of the Informatics 2000 Initiative to the Ministerial Roundtable on Policy and Infrastructure, Summit of the Americas, Santiago, Chile, April 1998.

Inter-American Development Bank (1998). *Education in the Information Age - What Works and What Doesn't*. Castro, C.M. (Ed.), Washington, DC, ISBN 1-886938-33-4.

Laires, M.F.; Ladeira, M.J. and Christensen, J.P. (Eds) (1995*). Health Care in the New Communications Age: Health Care Telematics for the 21st Century*. Studies in Health Technology and Informatics Volume 24. IOS Press/Ohmsha, Amsterdam, ISBN 90 5199 224 6.

Leão, B.F. and Sigulem, D. (1990). *Por que investir em informática médica?* Ciênc Cult (São Paulo) 42(5/6):372-374.

Lorenzi, N.M. and Riley, R.T. (1995). *Organizational Aspects of Health Informatics: Managing Technological Change*. Springer-Verlag, New York.

Lott, C.M. (1996). *Legal interfaces in telemedicine technology.* Mil Med 161(5): 280-283.

Mandil, S.H. (1995). *Telematics in health care in developing countries.* J Med Syst 19(2): 195-203.

National Institute for Standards and Technology (1994). *Putting the Information Infrastructure to Work: Report of the Information Infrastructure Task Force Committee on Applications and Technology.* National Institute of Standards and Technology, U.S. Department of Commerce. Washington, DC, U.S. Government Printing Office, May.

National Institute for Standards and Technology (1994). *The Information Infrastructure: Reaching Society's Goals.* Report of the Information Infrastructure Task Force, Committee on Applications and Technology. National Institute of Standards and Technology (NIST), U.S. Department of Commerce, Washington, DC, U.S. Government Printing Office, September.

National Science and Technology Council (1999). *Information Technology Frontiers for a New Millenium*. A Report by the Subcommittee on Computing, Information, and Communications R&D, Committee on Technology. Published by the Executive Office of the President of the United States. Washington, DC.

Neuberger, N. (1996). *New telecommunications tools for health care: beyond R&D into the next generation. In Telemedicine Sourcebook 1996-1997*. Faulkner & Gray's Healthcare Information Center, Faulkner & Gray, New York.

Nusbaum, M.H. (Ed) (1988). *Proceedings Second Annual Conference on Information. Technology in Community Health (ITCH'87),* Nov 22-25,1987, University of Victoria, B.C. Canada, ISBN 0 920313 78 7.

Office of Technology Assessment, US Congress (1995). *Bringing Health Care Online: The Role of Information Technology*. US Government Printing Office, Washington, DC, September, OTA-ITC-624.

Organization for Economic Co-operation and Development (1997). *Global Information Infrastructure - Global Information Society (GII-GIS): Policy requirements.* Committee for Information, Computer and Communications Policy Publication OCDE/GD(97)139, Paris.

Pan American Health Organization (1996). *Health Sector Reform: Proceedings of a Special Meeting*. ECLAC/IBRD/IDB/OAS/PAHO/WHO/UNFPA/UNICEF/US AID. Washington, DC, September 29-30.

Pan American Health Organization and Caribbean Latin American Action(1996). *Survey of telemedicine projects in Latin America and the Caribbean: Americas Healthnet.* Washington, DC.

Pan American Health Organization (1997). *Salud, Equidad y Transformación Productiva en América Latina y el Caribe*. Published in collaboration with the Comisión Económica para América Latina y el Caribe. Cuaderno Técnico no. 46. Washington, DC.

Pan American Health Organization (1997). *Tecnologías de Salud Uniendo a las Américas - Impulsando una visión: la implantación y el uso de la tecnología y los sistemas de información en el mejoramiento de la salud y la atención de salud*. Documento de discusión para la Segunda Cumbre de las Américas. Programa de Información sobre Servicios de Salud, HSP/HSI, Agosto 1997.

Pan American Health Organization (1998). *Information Systems and Information Technology in Health – Challenges and Solutions for latin America and the Caribbean*. Health Services Information Systems Program, Division of Health Systems and Services Development. Washington, DC. ISBN 92 75 12246 6

Pan American Health Organization (1999). *Setting Up Healthcare Services Information Systems – A Guide for Requirement Analysis, Application Specification, and Procurement*. Essential Drugs and Technology Program, Division of Health Systems and Services Development, Washington, DC. ISBN 92 75 12266 0

Patrick ,K. and Koss, S. (1995). *Consumer Health Information White Paper*. Consumer Health Information Subgroup, Health Information and Applications Working Group, Information Infrastructure Task Force Committee on Applications and Technology, Washington, DC, Working Draft, May 15.

Perednia, D.M. (1995). *Telemedicine system evaluation and a collaborative model for multi-centered research*. J Med Systems, 19: 287-294.

Pernice, A.; Doare, H. and Rienhoff, O. (Eds) (1995). *Health Card Systems*. Studies in Health Technology and Informatics Volume 22. IOS Press/Ohmsha, Amsterdam, ISBN 90 5199 225 4.

Puskin, D.S. (1995). *Opportunities and challenges to telemedicine in rural America*. J Med Systems, 19: 59-67.

Puskin, D.S.; Brink, L.H.; Mintzer, C.L. and Wasem, C.J. (1995). *Joint federal initiative for creating a telemedicine evaluation framework*. Letter to the Editor. Telemedicine Journal, 1(4): 395-399.

Rodrigues, R.J. and Malik, A.M. (Eds) (1993). *Preparing Health Care Managers for a Changing World: What is Our Role?. Proceedings of the International Seminar in Health Administration*. Instituto para el Desarrollo de la Organización y la Administración (INSORA), Universidade de Chile, and W.K.Kellogg Foundation, octubre 1993. ISBN 956 7424 01 2.

Rodrigues, R.J. and Israel, K. (1995*). Conceptual Framework and Guidelines for the Establishment of District-based Information Systems*. PAHO/WHO Office of Caribbean Program Coordination, Barbados. PAHO/CPC/3.1/95.1, ISBN 976 8083 75 1.

Rodrigues, R.J. (1996*). Information Systems Development and Health Sector Reform. In Proceedings of the Sixth National and Fourth International Conference on Information Technology and Community Health (ITCH96)*. Victoria, BC, Canada, November 3-6. pg 2-7.

Rodrigues, R.J; Crawford, C.M.; Koss, S. and McDonald, M. (Eds.) (1996*). Telecommunications in Health and Health Care for Latin America and the Caribbean. Preliminary Report of an Expert Consultation Meeting*. Washington, DC. Series 1/ Health Services Information Systems Program, Division of Health Systems and Services Development, Pan American Health Organization.

Rodrigues, R.J. (1997*). Health Systems in an Environment of Change. In Internet, Telematics and Health*, *Sosa-Iudicissa; Oliveri; Gamboa and Roberts (Eds).* IOS Press & Ohmsha, Amsterdam, page 55-60 ISBN 90 5199 289 0.

Sanders, J.H. and Bashur R. (1995). *Challenges to the implementation of telemedicine.* Telemedicine Journal, 1(2): 115-123.

Sapirie, S.A. (1994). *Strengthening Country Health Information: A New Strategy for Strengthening National Health Information Systems, Procedures and Networks* (draft). Geneva, WHO/SCI.

Sosa-Iudicissa, M.; Levett, J.; Mandil, S. And Beales, P.F. (Eds) (1995). *Health, Information Society and Developing Countries*. Studies in Health Technology and Informatics Volume 23. European Commission DG XIII and WHO. IOS Press/Ohmsha, Amsterdam, ISBN 90 5199 226 2.

Sosa-Iudicissa, M.; Oliveri, N.; Gamboa, C.A. and Roberts, J. (Eds) (1997). *Internet, Telematics and Health*. Studies in Health Technology and Informatics Volume 36. PAHO/WHO and IMIA. IOS Press, ISBN 90 5199 289 0.

US Department of Commerce (1997). *Networks for People: TIIAP at Work.* National Telecommunications and Information Administration, Washington, D.C. October.

US Department of Health and Human Services (1999). *Wired for Health and Well-Being - The Emergence of Interactive Health Communication*. Eng T.R. and Gustafson, D.H. (Eds), Science Panel on Interactive Communication and Health. Office of Public Health and Science. US Printing Office, Washington, DC.

US Goverment (1997). *A Framework for Global Electronic Commerce*. The White House, Washington,  DC, July 1.

Viegas, S.F. and Dunn, K. (1998). *Telemedicine – Practicing in the Information Age*. Lippincott-Raven, Philadelphia. ISBN 0 397 51843 9

World Health Organization (1988). *Informatics and Telematics in Health: Present and Potential Uses*. Geneva, ISBN 92 4 156117 3.

World Health Organization (1997). *WHO Cooperation in Strengthening National Health Information Systems. A Briefing Note for WHO Country Representatives and Ministries of Health*. Publication WHO/HST/97.2, Geneva.

World Health Organization (1998). *A Health Telematics Policy in support of WHO's Health-for-All Strategy for Global Health Development*. Report of the WHO Group Consultation on Health Telematics, December 11-16, 1997. Publication WHO/DGO/98.1.

World Health Organization (1999). *Trends and Challenges in World Health*. Publication EB 105/4, Geneva.

Zundel, K.M. (1996). *Telemedicine: history, applications, and impact on librarianship*. Bull Med Libr Assoc 84(1): 71-79.