Abstract - Continued advances in information technologies, computing and communication systems are enabling improved access to healthcare information, health services, research and education independent of distance. Combined they constitute the concept of Telehealth and are allowing enhanced means of sharing knowledge and expertise, “leap-frogging” over the barriers of distance and time. Global development and integration of communication systems such as Internet2 are creating opportunities for international collaboration using Telehealth as a platform for information and technology exchange with the potential to create a true “network of networks” and a “virtual collaborative model” that can be used worldwide. The Center for Telehealth and Cybermedicine Research, along with the Ibero American Science and Technology Education Consortium (ISTEC), both based at the University of New Mexico (UNM) have been working with other Latin American organizations and universities to develop an international network for cooperative exchange that is complimented through the use of Telehealth technologies.

Index Terms – Cybermedicine, Healthcare, Internet2, ISTEC, Telehealth, TeleSalud, Virtual collaborative models.

INTRODUCTION

Facing growing cases of chronic illnesses amid continuing nursing shortages, the health care industry is increasingly turning to telemedicine devices to keep tabs on patients. More than half of the 8,000 home care agencies in the U.S. that provide services to Medicare patients now use some form of remote monitoring. Sales of devices and digital services for home monitoring are projected to grow from $461 million in 2005 to over $2.5 billion in 2010 [1]. Agencies that don’t handle Medicare patients and tend to handle less complex illnesses are now deploying telemonitoring as well. Most patients get the equipment through a home care agency, though some insurers and hospitals also provide devices for their patients.

Low cost computing and ability to integrate technology with other non-traditional modes of delivery has changed the way business is done in almost every aspect of the modern world. From educational systems such as Learning Management Systems (LMS) to the most advanced supply chain management applications, system integration of multiple platforms is becoming a norm for successful business models. Since the late 1990 health care providers have focused on automating and integrating care delivery systems. This triggered integration of different IT systems of hospitals clinics. This triggered a massive effort to develop a system that can be compatible for data sharing and cross platform functions. Varying from a simple data warehousing to advanced e-diagnostics an integrated health care system will enable changes cost effective solutions and smooth exchange of information.

ISTEC conceives plans and executes activities related to higher education, research and development and technology transfer. ISTEC’s purpose is the facilitation of scientific and technical progress in the Ibero-American countries. ISTEC participants encourage the free flow and access of information in the pursuit of technical excellence. Through the activity of coordinating eminent personnel and resources from diverse geographical locations ISTEC has developed a mechanism called the Initiative, which is an organized effort to create activities and programs that addresses specific areas of concern. The Initiatives are member-driven, flexible, and run concurrently. Within initiatives, projects are identified, planned and implemented. The projects emanate from a distributed structure, which avoids duplication of efforts and inherently responds to the needs of the ISTEC membership.
Currently, there are several active Initiatives, programs and special projects.

The ISTEC Telehealth (Tele-Salud) project was conceived by an international group of medical doctors, health workers, and engineers interested in developing a collaborative program to share common experiences in the biomedical field. The objectives are not only medical in nature; rather, the program aims at developing a new interdisciplinary space that integrates biomedicine, engineering, computer science, and other disciplines. (In this publication the terms Telehealth, TeleSalud and ISTEC Salud are used interchangeably) ISTEC Salud seeks sustainable technological solutions to improve medical/health care access for underserved communities in the region and to provide innovative ways to facilitate access to knowledge and services in these fields.

Continued advances in information technologies, computing and communication systems are enabling improved access to healthcare information, health services, research and education independent of distance. In combination, these distance technologies and health-related applications constitute the concept of Tele-health [2]. In turn, Tele-health is allowing an enhanced means of sharing knowledge and expertise, “leap-frogging” over the barriers of distance and time. Global development and integration of communication systems such as Internet2 are creating opportunities for international collaboration using Tele-health and a platform for exchange with the potential for formation of a true “network of networks” and “virtual collaboration” that can be used world-wide. All database applications for the Telehealth purpose will use structured information of one kind or another, whether it is the accounting data, scientific measurements, or patient information. Structured data is easier and faster to retrieve than unstructured data.

Using SQL SERVER, by Microsoft, as a database will be advantageous for this purpose. This database provides a robust system for data storage, data back up and mirroring of data at another location so that it can be rapidly retrieved in case of an emergency.

There are two methods available that provide front-end capability for entering data and communication with the database. One is the traditional remote login to the database through a front-end interface. The other uses Remote Database Connectivity (RDC). RDC is the slower of the two methods. Since the system should provide quick access, rapid connection between all clients and the server, local and remote, must be a priority.

With the advent of the Internet and web related technologies the most popular method now being employed is a web page based format. A web page is accessed and the user enters the information and makes the proper choices, which goes back to a web server that invokes a Common Gateway Interface (CGI) script. This script connects to the database and processes the data or the request. It is a more preferred method since it is more performance oriented than traditional methods. A simple description of this web based Telehealth implementation with multiple servers is shown in Figure 1.

The Center for Telehealth and Cybermedicine Research, along with the Ibero American Science and Technology Education Consortium (ISTEC), both based at the University of New Mexico (UNM) have been working with other Latin American organizations and universities to develop an international network for cooperative exchange that is complimented through the use of Telehealth technologies. Furthermore, the collaborations will allow sharing of information and experiences in applying Telehealth within their respective countries and programs, as well as share information regarding medical issues of both common international and unique regional public health interest from various perspectives.

Examples of these developing initiatives include student and faculty exchange programs between UNM, USF ISTEC, la Universidad de Carabobo in Venezuela and la Universidad Tecnológica Equinoccial in Ecuador. These programs would allow the development of face-to-face cooperative exchange projects of mutual interest between countries with improved communication and follow-up using the Telehealth technologies in order to sustain these projects and overcome the additional cost and time of repeated travel. Due to that interaction the College of Health Sciences at the University of Carabobo has undergone major organizational changes embedding the new Technologies of Information and Communication (TICs) as a component of the Departmental structure. Furthermore it has created two specialized Centers for TIC (CETICEA, one in Valencia, in State of Carabobo and another one located in Maracay, in the State of Aragua). Another project being explored is the integration of Telehealth into the Latin American component of the international tuberculosis program directed by a faculty member from UNM that currently has collaborative sites in Bolivia, Brazil, Colombia, Mexico, and Peru. Similar collaborative projects.
are being developed regarding cancer case reviews between Mexico and New Mexico. In addition, a team in Venezuela has designed a boat equipped to do telemedicine on the Rio Capanaparo in Los Llanos of Venezuela Sur. This concept is also being explored for similar use in Ecuador on the Rio Napo, particularly as it applies to the increased incidence of certain cancers in association with gas and oil drilling in the region. There is also interest in developing programs that include traditional native healers in the international collaborative Telehealth applications, an important component of wellness and health in many countries. These traditional healers could share their knowledge and experiences with each other, students and conventional health providers. Lastly, a project that allows distributed immersive interactive virtual reality simulation for collaborative real-time medical education and training over Internet2 is being explored with several countries, including institutions within Latin America.

**INFRASTRUCTURE - ISTEC**

ISTEC is a non-profit organization comprised of educational, research, industrial and multilateral organizations throughout the Americas and the Iberian Peninsula. In the last 15 years ISTEC has successfully partnered with renowned companies such as Motorola, Intel, Sun Microsystems, Hewlett Packard and Xilinx, among several others, to foster scientific and engineering education, as well as technology transfer.

As a result ISTEC has established 172 research and development laboratories in 17 countries within the Ibero-American region. These laboratories have provided a fertile training ground for over 600,000 undergraduate and graduate students.

The current vision is to launch the ISTEC TeleSalud program as an embedded component of ISTEC’s existing 4 initiatives. As a first step, ISTEC TeleSalud would facilitate adoption of standardized electronic medical reports, software and the creation of regional health information networks that can exchange data and patient records. The major challenges looming over the health care is the need to expand the scope of information sharing beyond the walls of individuals. Currently, patient care is provided by an unconnected collection of facilities hospitals, physician office, home health agencies, clinical laboratories, and rehabilitation centers. ISTEC TeleSalud will enable these competing providers woven into networks with out boundaries that can easily share and exchange patient information in order to provide the best possible and more cost-effective care.

The main objectives of ISTEC TeleSalud are to:

- Develop an international “Sharing Knowledge Network” to share experiences and approaches to particular local needs
- Integrate engineers and other technology experts with medical and health practitioners in order to create an interdisciplinary critical mass to share research/knowledge in order to improve local issues within a global context
- Create a distributed, interdisciplinary, inter-institutional international, and interactive network of collaborators to provide a stimulating and synergistic platform for engaging and energizing participants in a variety of domains that support the research, development, and implementation of Telehealth / Telemedicine efforts

**Initiatives**

The objective is to develop a new interdisciplinary field that integrates biomedical engineering, information technology and computational science. This initiative looks for technology based solution development to network health care in small communities by developing innovative ways to facilitate information access. A strong network infrastructure of ISTEC has the following successful initiatives that have lead to the conceptualization of ISTEC TeleSalud. The following are the initiatives that ISTEC TeleSalud has successful put in place with all its partners.

- **Digital Libraries Linkages Initiative:** One of the basic tenets of science and technology is access to up-to-date information in real time. This Initiative aims to modernize document delivery as a complement to education, research, manufacturing and policy design. Additionally, the initiative proposes to broaden electronic availability of research materials, to upgrade the information skills of library staff and to sharpen the skill and independence of the electronic user.

- **Advanced Continuing Education Initiative:** The key to the development of any nation is the availability of highly qualified human resources. This initiative seeks to upgrade the available skills and increase the number of qualified individuals in applicable areas. Projects conducted within this initiative involve curriculum adaptation, design and enhancement, professional development, accreditation, on-site training and web-based distance learning. In addition, the initiative utilizes non-traditional faculty, staff, and student exchanges, including “sandwich” graduate programs. Of particular interest is the development of materials that incorporate the latest technology in state-of-the-art textbooks and laboratory materials and in the way systems are developed for the education process.

- **Research and Development Laboratories:** The purpose of the R&D Laboratories Initiative is to provide educators and researchers access to state-of-the-art technology for use in teaching advanced technological concepts and experimenting with new techniques. In so doing, the Initiative addresses the lack of current information and resources for planning and developing technology, the
lack of international cooperation in developing the critical mass needed for projects and joint efforts, and the lack of interaction (lack of confidence and sometimes lack of information) between universities and industries. Laboratory facilities are designed to be modular and flexible, providing an environment for a wide-ranging, adaptable laboratory system. Many ISTEC member institutions have similar laboratory facilities and are presently upgrading curricula in telecommunication, digital signal processing, microprocessors, control, and other areas. This same method is being used in other areas as well, allowing institutions to have access to updated networking technology, to telecommunications equipment, to advanced software platforms, and to new computer equipment and methods. Along with the access to this technology, databases and information repositories are being created to allow sharing of ideas, techniques, methods, and materials to minimize the duplication of efforts throughout the region. All of this information is available to the ISTEC members involved in the projects. An additional benefit of this mechanism is creation of a vehicle for university-industry collaboration.

- **Los Libertadores**: This initiative is a “common thread” effort that links together all of ISTEC’s goals and objectives. It seeks to create a flexible network of telecommunication services (a hemispheric backbone for academic and R&D purposes), computing facilities, and teaching stations, known as “Centers of Excellence”, see figure 1. Each country or region identifies needs that must be met, and then designs a Center of Excellence to address those needs. Each Center of Excellence brings together people from the private sector, the public sector, and the educational system to work together to find solutions to the problems of interest. Since those problems invariably have multiple facets, the solutions must involve multiple disciplines and the diverse contributions available from each sector. It is important that the Center be adapted to the needs of the country, identifying those areas that can be most beneficial for all the participants and finding effective methods of collaboration. Thus, the Center may not be a central building, but rather a network of capabilities distributed throughout an area. ISTEC is actively working with several governments, international funding agencies, and professional organizations to highlight the importance and critical nature of this effort in the economic, social, and cultural development of the nations in Ibero-America.

- **Information Communication Technologies for Social Development (ICTSD)**: The objective of the Information Communication Technologies for Social Development (ICTSD) initiative is to spur an international strategy for generating and supporting collaborative activities among academia, industry, government, and marginalized communities in the Ibero-American region and to promote community development through the use of Information Communication Technologies (ICTs). Additionally, a companion goal is to challenge communities to develop new organizing tools that can contribute to a bottom-up approach to cultural and socio-economic development that is created by rather than for community members. This proactive and action-oriented approach is aimed at creating the synergy needed to empower indigenous communities to develop innovative ways to use technology applications that improve economic development and the quality of life within their communities.

- **Science and Technology Entrepreneurships for Economic Development (SEED)**: The objective is to combine the Science and Technology potential with the New Mexico Technology Commercialization expertise in order to create partnerships with Universities, Governmental Organizations, and Ibero-American Companies. These partnerships would create new organizations that combine their business experience and technical knowledge to foster the development of economic activities in Ibero-America, New Mexico and the USA. These activities would require participation by Engineering departments, schools of management, medicine and biology, as well as governmental organizations, laboratories of research and development, and financial entities.

**INTEGRATION PROJECTS**

ISTEC member institutions have various successful technology integration projects. One such integration is called “Rapid Diagnosis of Malaria and Dengue Fever”. In this project University of South Florida (USF) was about to integrate technologies and demonstrated rapid detection of microorganisms in drinking water and infectious diseases. These techniques are based on off-the-shelf portable, miniaturized spectrometers and measurement probes. The measurement systems are the size of a wallet, autonomous, and can be readily deployed in disaster areas to monitor the water supplies and serve as portable laboratories for medical diagnosis. In addition, the hardware can be configured with appropriate communication systems to transfer the data from remote and/or affected locations to processing centers where the data can be analyzed for diagnosis purposes. Other capabilities of the technology, which make it relevant to disaster areas, include in-situ blood typing for transfusions, measurement of arterial oxygen saturation and hematocrit and total hemoglobin. Very importantly, these equipments possess minimal training requirements.

The significance of the research was that it validated portable, economical, instrumentation for rapid diagnosis. The research also provides estimates of the cost reduction and efficiency of the diagnosis process. The importance of the development and validation of the proposed technology can be summarized by the statistics, which indicate that 6.5 million people, mostly children, die from Malaria in Africa alone. To test and validate the technology it was necessary to have a laboratory in a location with a high incidence of infectious diseases. It was also necessary that the location have the clinical infrastructure for validation and the capability to...
transfer the data back to the US for analysis. The decision was made to take advantage of the existing relationships that existed with INSALUD - and the Universidad de Carabobo in the city of Valencia, Venezuela. These two centers have access to a large number of patients who suffer from Malaria and Dengue Fever. In addition, they have the necessary infrastructure for clinical diagnosis and laboratory validation of the proposed technology. Furthermore, these institutions follow all the established protocols for dealing with human subjects. Another important consideration was the ability to establish both an Internet connection and a satellite up-link to transfer data to the US. The collection of non-invasive and minimally invasive diagnosis data throughout a four month period, coupled with the clinical analysis was deemed adequate to provide the data necessary for the pilot field-testing and validation of the technology. The importance of prevention, diagnostics and control of emergent and reemerging infectious diseases and the need to develop an international infrastructure capable of responding with satisfactory and on-time solutions based on state-of-the-art technology and more importantly based on realistic solutions. It is expected that the participants will commit to actively participate in the development of a network for the exchange of information within the participants’ countries and the research faculty of the College of Public Health at the University of South Florida. This was a collaborative effort between the University of South Florida, ISTEC University of New Mexico, ISTEC-USF and Hidalgo’s Medical Center for Education & Technology Research Inc. As an outcome of this project, multimedia based educational material was developed for general distribution to the region by using the Ibero American Science and Technology Educational Consortium (ISTEC) network based at the University of New Mexico which is linked to its membership, which consists of over one hundred Latin American Universities. Figure 2 illustrates the networking of a Personal Digital Assistant (PDA) to wireless let works.

Other health initiatives worth mentioning are University of South Florida’s experience with the Public Health Leadership Institute and the experience of integrating technology for post Hurricane Katrina public health relief work. This project was coordinated with 8 federal agencies and provided data collection and networking using a PDA.

**IMPACT OF ISTEC TELESAUD**

The business of health care information system is beyond the limits of traditional software development. ISTEC TeleSalud will have the greatest impact in basic medial record sharing, regional health information networking and eventually across boarders [3]. In the United State along there are hundreds of heath management systems that have emerged and many of them independent of the other. ISTEC Health system proposes a system that would establish standard communication and data sharing protocols and procedures. This would enable small and big health care providers will be able to collaborate resulting in cost saving and efficiency. Some of the main objectives are to:

- Develop an international “Sharing Knowledge Network” to share experiences and approaches to particular local needs
- Integrate engineers and other technology experts with medical and health practitioners in order to create an interdisciplinary critical mass to share research / knowledge in order to improve local issues within a global context
- Create a distributed, interdisciplinary, inter-institutional international, and interactive network of collaborators to provide a stimulating and synergistic platform for engaging and energizing participants in a variety of domains that support the research, development, and implementation of Telehealth / Telemedicine efforts
- Develop ideas for joint projects in “Traditional” or “Alternative” healing and Conventional medicine
- Address common needs to the region, such as rural access to medicine
- Identify funding needs to the region, such as rural access to medicine
- Facilitate international collaboration and weave a broad spectrum of programs in a manner that honors cultural

The objective of this project through ISTEC is to define the points in which we can support a major initiative through mutual support and effort. This coordinated effort will enable technology for teaching and certification of medical doctors and students of health sciences; research priorities; medical services and health standards for traditionally marginal communities; environmental health; the articulation of different health workers and agents who are schooled in Western and traditional medical practices, referring to indigenous communities, African-American communities and, in general, rural peoples. Here we are especially interested in the sympathetic training of health-care workers, the production of educational materials to enrich programs in rural and community health, and the uses of IT to solve health problems over long distances. Finally, ethical and legal problems related to telemedicine are pertinent to ISTEC-Salud, considering the ethical principals that should govern medical practices at a distance, the use of virtual reality technologies in medical training, the management of medical records, and respect for legislation now in place in various countries of the Americas [4]. We discussed the need to have a
common set of standards and to require that projects endorsed by ISTEC-Salud should have the approval of the relevant institutions in the country involved; this is particularly important for respecting the belief systems and health-care practices of native communities as well as for issues of accreditation and mutual respect among the different countries in which ISTEC-Salud may be involved in projects of teaching, research, and public service.

CONCLUSION

This paper summarizes the on-going efforts by the program ISTEC-Salud under ISTEC. The relevance of tele-salud within the region is presently being highlighted by the available funding such as the USA Rural Development that has announced a Distance Learning and Telemedicine (DLT) program grant. The anticipated grant funding is $20 million, with a maximum of $500,000 and a minimum of $50,000 [5-8]. In addition, the funding for FY 2005 was approximately $29.4 million. These figures show huge support from the US government for research and application development in the US.

In 2003, USAID’s Global Development Alliance invested $1 million to expand a telemedicine network throughout Latin America and the Caribbean. Satellite ground stations were built in Bolivia, Brazil, Guatemala, Mexico and Panama to allow remote communities in these countries to receive medical education programming [9-10]. The application of the cooperative Tele-salud concept to the Americas can serve as a model for other countries throughout the world. As the world continues to “shrink”, developing an international telehealth network of networks offers an opportunity for cooperation, collaboration, knowledge sharing and improving the health of every individual in the world, applying information technologies for peace and the betterment of mankind.

REFERENCES