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Telemedicine application at the University of Rochester Medical Center Strong Memorial Hospital in conjunction with the New York State Department of Corrections

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Telemedicine Application at the University of Rochester Medical Center Strong Memorial Hospital In Conjunction with the New York State Department of Corrections

By

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Strong Memorial Hospital (SMH) And A Practical Implementation in conjunction with the New York State Department of Corrections (NYSDOC)

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Acknowledgement

This is dedicated to my three lovely daughters,
Christal Jean
Maria Jeannette
Rebecca Jean
They have been patient enough….

To all of the staff of the Department of Information Technology at Rochester Institute of Technology for making my learning experience so memorable and enjoyable. To dear Prof. Niemi who never gave up on me. To Prof. Haake for taking on my case at a short notice and being so supportive. To Mike Myers for being such a good friend and colleague.

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Finally, to all of my friends, who had unrelentlessly gave their support to finish writing the thesis….

Medicine is here so that the patients survives, not the doctors.

Jay Sanders, M.D.
Telemedicine Day, April 28, 1998
University of Rochester, Strong Memorial Hospital
Rochester, New York

Abstract

Telemedicine has been around for several years and it is inevitable that this technology will shape the current healthcare environment. Doctors are often faced with the challenges of the laws of time and distance. With the presence of telemedicine, the idea of having access to a physician at any given time becomes a reality. This paper will present an exciting concept of telemedicine for today and tomorrow with an emphasis on the advancement of health care delivery systems.

This thesis will also attempt to present the cost saving factors that telemedicine can provide not only to patient care but also to the financial and administrative aspects of healthcare. It will provide a summation of goals, design description and the initial cost of implementing a telemedicine application.

This paper will be a combination of discussions on general telemedicine applications and a practical implementation. It culminated with a presentation of an actual telemedicine project that the University of Rochester Medical Center implemented in conjunction with the New York State Department of Corrections telemedicine project. I was a member of the team that designed and implemented the first “true” telemedicine application for Strong Memorial Hospital.

It consists of an outlined discussion as presented on the Table of Contents and the networking design proposal to implement a telemedicine project.

The paper also investigated some other telemedicine applications at the University of Rochester Medical Center that can be implemented in the future. We tried to follow a rigid timeline, but due to some delay on procuring the leased line we fell a little behind on the implementation. The committee for Telemedicine in Strong Memorial Hospital met on a regular basis and assessed the technological needs of each department. Below was the tentative timeline for the project itself. The dates changed based on how promptly the vendors were able to meet the project requirements:

March 30, 1998 - T1 Installation
March 15 – 20, 1998 – Support Staff Training
April 15, 1998 - Test Phase
April 30, 1998 - Final implementation

My primary role in this implementation is to design the wide and local area network for the University of Rochester Medical Center. I also participated in several of the committee meetings which outlines other administrative issues involved, such as the emergency room renovations, feasibility of extending video conference services, discussions on cost and billing issues, and a visit of an actual correctional facility to observe its telemedicine application.

GOALS AND OBJECTIVES

To maintain a leading edge as an academic and clinical institution, the University of Rochester Medical Center has given serious consideration to procuring telemedicine technology. The telemedicine project has enabled hospital physicians to connect with remote sites and "visit" with the patients in some of the correctional facilities in New York State, e.g. the Albion Correctional Facility. This project was also utilized to link to other regional hospitals for grand round presentations, clinical consults and patient triage, enroll patients in clinical trials, and educational training and administrative conferencing. The project provided a much-needed presence for Strong Memorial Hospital within the region.

The initial telemedicine implementation was to be the trial project that will provide the hospital management with a basis for approval of further telemedicine funding. The initial project was funded fully by the hospital administration and will be re-evaluated within a year for future applications and financial support.

The overall goal was to develop a telemedicine network which will provide consultative support to the NYS Department of Corrections, and to evaluate this network as to its feasibility, utilization, patient acceptance and satisfaction, and cost.

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What is important here is that telemedicine is a system without borders. It is not a new kind of medicine. It is a way of communication that makes it possible to utilize existing medical resources in a new and much more efficient way.

Steinar Pedersen, M.D.
Head of the Department of Telemedicine
University Hospital of Tromsoe, Norway

INTRODUCTION

In the healthcare industry, telemedicine is a growing business. It is a medium to reach patients in need of health care who would otherwise be left isolated. The telephone has helped telemedicine gain its popularity. It offered the first and simplest application of telemedicine by providing the physicians an instrument in closing the geographic gap in healthcare services. They were able to respond immediately to both minor and major patient complaints. Physicians were able to teleconference and discuss patient cases without having to drive to remote areas. Then came television and the ability to transmit images across a wire. The physicians were then able to determine a diagnosis and a treatment without having to be present with the patient.

"Medicine at a distance" is one of the most basic definitions of telemedicine[1]. The technology involves a mixture of advanced telecommunications equipment that is integrated with today's sophisticated medical technology. With its many applications, medicine is made available to many cities and rural areas all over the world.

The technology available for telemedicine has improved drastically throughout the years. It is a continuing challenge and the healthcare industry is definitely a candidate for improvement in the areas of "information" highway. Competition has increased in the telecommunications business in the last ten years providing a much wider product choices for telemedicine applications. Yet, even with the breakup of AT&T in 1984, the industry deregulation has discouraged business entry into dramatic new telecommunications services because of the threat of government interference or litigation among competing business interests[2]. All gears have shifted with the government very interested in utilizing telecommunications growth as a major economic goal. We now see an unleashing of investment in the field of telecommunications and it's telemedicine applications.

A BRIEF HISTORY OF TELEMEDICINE

Dr. Kenneth T. Bird was the first big name in telemedicine when, in 1962, he developed a plan for "telediagnosis". It started when Dr. Bird received a call reporting that an older woman had seriously injured herself in a fall and was not allowed to be moved. Part of Dr. Bird's frustration was not being able to consult with the patient at the Massachusetts General Hospital. He would need to travel hundreds of miles. This gave him the vision of being able to watch the patient on television.

With a grant from the United States Public Health Service, Dr. Bird planned to configure two television monitors and equip them with microwave units. The units transmitted signals creating a full-motion interactive video service. His first political battle was with The Federal Communications Commission (FCC). The FCC delayed giving the permission to activate the link until April 1968 due to the fact that microwave channel was not yet an acceptable transmission system.

The first patient to benefit from this new project was a patient who had an acutely swollen left knee. The patient at the Logan Hospital was placed in full view of the camera in Massachusetts General while the physicians diagnosed the patient. The doctors were able to correctly diagnose the patient with an acute "traumatic intrapatella bursitis". The patient was prescribed treatment and medication over the television. In 1975, while Dr. Bird was delivering a speech at the University of Michigan, he told the story of when a patient, upon leaving the hospital, stated that it was as if he was beside the physician. [1]

Over the next few years, Dr. Bird became very active with the telemedicine applications. Bird and several of his colleagues at Massachusetts General tested the telemedicine application's reliability by comparing remote diagnoses with those that were done on the same patients via an actual hospital visit. The research showed that 98 percent of the patient diagnoses, utilizing the unrefined interactive television, were accurate. The other 2 percent could be blamed to doctors making conservative diagnoses so as to protect the patient.

Later, there came other challenges from other departments. At Massachusetts General, almost all the medical chiefs embraced the technology, except for one Dr. Tom Dwyer, Chief of the Psychiatric Department. He was convinced that telemedicine would not work for his patients. According to Dr. Dwyer, the "cold" technology eliminated the real feeling of warmth and ambiance that exist between patients and physicians.

By securing another grant to implement a "telepsychiatry" application, Dr. Bird patiently provided proof that telemedicine could also be used for psychiatric consultations. Amazingly, given the ability to miniaturize the physical view of the psychiatrist in the background, the patients dealt with the sessions more comfortably.

Other pioneering physicians followed Dr. Bird's vision and launched several telemedicine experiments. Dr. A. Max House set up the oldest continually operating telemedicine program in the world at the *Memorial University of Newfoundland (MUN)*. Utilizing the joint Canadian and United States Hermes Satellite, he elected for a one-way television and a two-way interactive audio configuration. Their efforts launched a terrestrially-based teleconference in 1979 at a much lower cost. The program expanded in the mid-eighties to include Africa and the Caribbean. The *Satellites in Health and Rural Education* (SHARE) was formed in 1985 by the *International Satellite Organization* (Intelsat) and the *International Institute of Communications*. Utilizing the SHARE project, the MUN Telemedicine Group set up a telemedicine link between facilities in Nairobi, Kenya, and Kampala linking those East African cities to MUN. The project lasted for 10 months but resulted in the transmission of roughly 100 EEG's from East Africa to the MUN staff. The satellite service was a free service offered by Intelsat. The equipment at the remote site featured an electrode cap and transmitter. The transmitter converted the brain wave patterns to analog signals in the voice bandwidth for transmission over the network. In 1986, MUN took the project another step and linked six Caribbean countries on the University of the West Indies teleconference system. This extended project lasted only for six months but it did offer the foundation for a successful data and voice transmission design called the Intra-Jamaican project.

Another milestone in the history of Telemedicine is the development of the "Telemedicine Spacebridge". It started in December 7, 1988 when a massive earthquake devastated Soviet Armenia. 25,000 died and 125,000 people suffered head and spinal injuries, crushed limbs or organs, loss of blood, and disfiguring wounds. Armenia's medical system was overwhelmed and at the same time many of the health care providers were among the dead or injured. Many of the Soviet Union doctors were rushed to the scene to assist with the devastation. NASA proposed to the Soviet government that the two nations could activate a satellite-based medical consultation network. Its goal was to transmit expertise to Soviet medical personnel in areas where they had an expressed need, i.e. re-constructive surgery, physical and psychological rehabilitation, public health and epidemiology. The program was put under the auspices of the existing bilateral Space Agreement between the United States and the Soviet Union concerning the Exploration and Use of Outer Space for Peaceful Purposes.

The program was also plagued with political issues as well as deeper questions concerning the medical aspects of the program. The teams from both countries were forced to develop new standards for medical information transmission, as well as protocols and schedules on conducting consultations. Both countries had to take reciprocal trips to the counterpart country to investigate and learn more about the differences between their medical processes. Five months after the last tremor stopped, an open and a steady dialogue over a one-way video and a two-way audio link was established. On May 4, 1989, both medical teams tackled the post-acute rehabilitative needs of Armenia's sick and injured, and the slow process of rebuilding Armenia's medical system.

On June 4, 1989, near the town of Ufa, North Russia, another tragedy struck when two trains passed each other in a cloud of natural gas that was leaking from a pipeline. The gas leak sparked an explosion, which killed hundreds of people, and thousands more suffered burns and trauma. One of the trains carried mostly children. Since telemedicine application has been implemented in Armenia, it was easy to put a satellite clinic at the Ufa Medical Center. The emergency group was then serviced by the Armenian and the American medical group.

The Telemedicine Spacebridge lasted only until July 28, 1989 with an official count of 210 cases discussed. NASA's partners included hundreds of doctors from different university hospitals in Maryland, Texas, and Utah. The Soviet medical partners included 60 lecturers at the Yerevan Medical Institute of Advanced Physician Training and 50 directors of various medical institutions. One of the major concerns of the doctors involved with the project is the fact that having multiple specialists at multiple sites would lead to confusion or even contradiction of one another's diagnoses, but the opposite happened. Dr. Bruce Houtchens, a central figure in the Spacebridge project, said that "The American physicians at least, said one of the things they missed when the Spacebridge program was terminated with Armenia – where we were, in fact, doing real patient consultations – was the lack of contact and critique by their peers in a real-time, on-line fashion."[1]

Even through the Telemedicine Spacebridge terminated, it opened the gateway for future implementation. In 1990 and 1991, after two international telemedicine conferences, NASA and the Moscow Ministry of the Interior took steps to establish a partnership. This partnership will allow for a steady exchange of Russian and American medical expertise; and in 1992 a signed agreement was produced between the United States telemedicine delegation and the Russian officials that established the protocols for future collaboration.

There are several countries that have provided telemedicine experiments to further empower their physicians. In India, a telemedicine project offered the promise of radically changing healthcare for the country. About 80% of India's population, 700 million live in rural areas and medicine is not readily made available to them. With the aid of telemedicine, the specialists were able to communicate to these areas using two-way audio and video equipment. Even if the application offered good results, it still fell short in sound quality, therefore casting doubt on the credibility of some diagnoses, such as specialists who listens for subtle shifts in the heart pitch and changes in the skin tone. The physicians are concerned that even with a good network may not be good enough or reliable enough.

In Australia, telemedicine conquered the vast distances that separated many towns from modern health care. One challenge comes from the giant state of Queensland, stretching 1,300 miles north-south and about 700 miles east-west, the state was populated by only 30,000 healthcare providers. With the assistance of a government sponsorship, the North-West Telemedicine Project was implemented to serve five isolated towns in Queensland.

Norway also sanctioned telemedicine as a new and exciting adjunct to face-to-face healthcare. Singapore's aggressive use of advanced communication systems will make telemedicine an instant reality there, too.

All over the world, both the healthcare industry and the government are collaborating to find ways to explore the telemedicine technology. It has been proven that even if the initial implementation of a telemedicine project could be costly, the advantages still outweigh the disadvantages.

Dr. Jay Sanders is nationally recognized as a telemedicine pioneer and a very active advocate of improved access to healthcare services. He was the President of the American Telemedicine Association for two years and stepped down from his post on April of 1998. He still continues his work as a vice-chairman of the Rural Health Care Corporation. The RHCC is a FCC appointed agency administering mandated telecommunications discounts to rural providers. Dr. Sanders is also the President of The Global Telemedicine Group in McLean, Virginia. In the course of my working on this thesis, I had the privileged of meeting Dr. Sanders and witnessed his true dedication to the technology.

Photo 1: Dr. Jay Sanders & Dr. Alice Pentland during the Telemedicine Day at Strong Memorial Hospital

TELEMEDICINE AND ITS DRIVING FORCE

The current technology of telemedicine has proven that it does improve health care delivery and have paved the way to widespread adoption. It provides easy access to health care and has been instrumental to hundreds of collaborative research and consultations.[13] For years, the continuing mêlée on regulation and government interference has discouraged many healthcare institutions and business to enter the world of telemedicine (refer to section on HIPAA for governmental issues).

Telemedicine today has become a major key player in the field of information technology. One would be curious if the demand for sophisticated telemedicine applications drives our insatiable taste for advanced and improved technology or vice versa. The need for high quality health care is one of the driving forces of telemedicine, enabling to close the gap between the patient and the healthcare providers. Implementing a telemedicine project has also been less cost prohibitive. With the rise in competition between telecommunication service providers, accessing the information highway became uncomplicated and less tedious. Prices for telecommunications access has become very competitive and cost effective.

There has also been a major shift in the patient mentality. Gone are the days of uninformed patients. The Internet, having been made available to the major part of the population, offers an inexpensive form of communication between the healthcare providers and their patients. Today, there is an increase demand from the public for patient information and records to be made accessible. Patient education has been a focal point of most treatments. By educating the patient with the success rate and risk factors, the physician transfers a new sense of responsibility to the patient. Telemedicine enables the transfer of this knowledge right to the patient's living room. The Internet also provides medical institutions an inexpensive and readily available test bed for the commercialization of telemedicine technology.

Telemedicine has stirred interest in all sectors of the business. Vendors, such as PictureTel, RadVision, and Lucent are investing heavily in the technology and shifted the focus not only on their "videoconferencing" features but also promotes their telemedicine applications. Healthcare institutions are making sure that they are not behind the times and are also investing in telemedicine implementation to position themselves competitively. Meanwhile, the regulatory bodies, such as the Federal Communication Commission (FCC) and HIPAA (Health Insurance Portability and Accountability Act of 1996) are making sure that there are laws and policies in place (refer to section on HIPAA).

The Internet has also been made widely available and has become a usable transmission system for a lot of the telemedicine deployments. The challenge is to balance its commercialization with security and affordability. The current growth of the Internet is consistent with other services made available to telemedicine such as speech recognition, centralized clinical systems, and speech translation.

Telemedicine is here to stay and its one answer to our need to improve the overall administration of healthcare. It could only move forward and more accepted. Its continued success will rely on both national policy and the overall public mentality towards the technology.

ADVANTAGES OF TELEMEDICINE

Aside from the obvious time-saving and distance-reducing benefits, telemedicine offers a variety of other benefits.

Integrated Consultation: In a traditional consultation, where several physicians are involved, keeping the patient record updated poses a problem. The patient has to have a visit with each physician and each physician must update his own records. According to the Institute of Medicine, about 70 percent of the hospital records are incomplete; 30 percent of the physicians have limited access to the patient records; and approximately 22 people in hospitals depended on access to patient records at a given time. In a telemedicine consultation, the referring physician, consulting specialist, and the patient are often together for the consultation. This is further enhanced with the automated medical information systems providing easy access to patient records. After a telemedicine consultation, the patient data can be entered onto an electronic patient database, which can also include the physician diagnosis. Each patient has a medical record in a clinical database system, which can contain demographics, medical history and even the patient's laboratory results. The computerized medical record keeping also verifies gaps in medical information and checks for any obvious inconsistencies.

Increase Patient Access: One obvious benefit of telemedicine is reaching patients regardless of distance. For years, due to government regulations on telecommunication policies, technology was slow to catch up with the demands of telemedicine. Acceptance within the medical community was only half of the battle. Providing the transmission systems to connect remote areas was another challenge. The forms of transmission of data or information across the wire have slowly improved. Today, telemedicine can enjoy several choices of transmitting its information --- via Satellite connection, T1 to T3 line connection, Integrated Services Digital Network (ISDN) lines, or even the regular analog lines (Appendix C). Telemedicine aided in reducing medical isolation and has provided access to healthcare in previously unserved or underprivileged areas.

Improved Quality of Care: Because of the integrated form of consultation, with the patient and physicians consulting simultaneously, it provides the synergy derived from a healthcare team approach. The patient is encouraged to tell his symptoms directly to all the physicians and the physicians apply a synchronized plan of action. It fosters greater patient involvement, enhances compliance to treatment and it increases patient knowledge.

One beneficial application is the ability to record the consultation in full-motion video. This allows the physicians to review the session repeatedly, if necessary. With patient permission, it can also be used for future reference. There is also the ability to freeze a frame of the video exam record. This will have special benefits in pediatric medicine, where a sick two-year-old may not respond to a doctor's command to "sit still". Also, the ability to automatically access on-line medical literature services such as the Scientific American Medicine Consult (SAM). Aside from transmitting a treatment program for a particular case, the consulting specialist could also send relevant literature regarding the case. Some of the benefits of telemedicine that affects the quality of care are as follows:

- An electronic data processing technique that offers a more sophisticated analysis of health care utilization and clinical outcomes.
- It provides electronic administration and billing for services that extends the cost savings to patients.
- Computer-based decision support tools that can help reduce variation in health care quality across providers, improve adherence to standards of care, and reduce costs by eliminating duplicative or non-efficacious tests and therapeutic procedures.
- Introduced many telemedicine programs that overcome geographic boundaries between patients and healthcare providers. It provides electronic search engines of health issues both for the patient and the healthcare provider.

Reduced Cost: Cost for travel includes both time and money. Telemedicine provides patients access to specialty care without having to travel to specialty clinics. It offers healthcare providers access to medical video conferencing without having to travel for continuing education, therefore eliminating distance issues and travel cost. Healthcare institutions have reduced their cost by combining their emergency services using telemedicine; such is the goal of the University of Rochester Medical Center telemedicine applications. There is really no authoritative standard for calculating cost savings when implementing a telemedicine project. A general formula have been developed that compares costs incurred to costs saved and productivity recovered. To make these calculations, it is important to record utilization in a monthly user's log.

- Names and Positions of all Participants
- Record Every use of the System
- Length of each Connection
- Names of all Sites Connected during a call

In addition to these data, one-time calculations must be made for the following:

- Travel Distance to Each Site (fuel or mileage reimbursement)
- Travel Time to Each Site (lost productivity per person)
- Salary Range for Each Position
- Costs for usage and equipment

Savings can be determined by comparing the cost of owning and operating the system against the costs saved by reduced travel and increased productivity (time not spent traveling to other sites). This calculation has been used to justify continuation and expansion of services at several health care facilities. The American Telemedicine Association suggested this cost-saving formula:

Savings = (Travel Costs + Time) - (Equipment +Telecomm)

(The equipment must be amortized over time and the costs for travel must include travel reimbursement and travel time for each participant) [14]

According to recent statistics from the department of justice, the cost of providing outpatient care to the prison populations has been estimated to be as high as $1,000.00 per inmate visit. The cost varies considerably depending on the type of medical care received, the number and salaries of the security officers and the drivers involved.

We can apply this formula with the NYSDOC and URMC telemedicine implementation. Most of the outpatient care for inmates are done during normal business hours which leaves 240 days per year. Per inmate visit averages 4 hours, inclusive of travel time, wait time and actual consult time. Based on this estimate, an outpatient care for an inmate will roughly be:

Min. of 4 hours x $15/ hr/security officer = $60.00

$60 x 3 security officer = $180.00

Attica to Rochester = approximately 120 miles round trip

120 miles @ 0.32/mile = $38.40

I used $0.32 per mile because it is the federal standard mileage cost normally used for tax purposes. It is safe to assume that the initial investment for the telemedicine equipment would be good for seven to ten years before it gets obsolete. Based on the proposed budget as outlined on Appendix A, the capital cost for the Emergency Department is broken down to:

Total cost = $49,593.00 / 7 years = $7,085.00 / 240 days = $30.00

Recurring Telecomm Monthly cost = $419.96 / 30 days = $14.00

Following the suggested formula, there will be an estimated $152.00 savings per inmate outpatient care visit.

Savings = (Travel Costs + Time) - (Equipment +Telecomm)

= ($180.00 + $38.40) - ($30.00 + $14.00)

= $218.40 - $44.00

= 174.40

DISADVANTAGES OF TELEMEDICINE

As any other healthcare issues, telemedicine has its share of concerns. Because modern technology is a major part of these projects, there can be many impediments. In today's healthcare, physicians are forced to routinely collaborate with computers, imaging devices, electronic communicators, or even robots. In some cases, orthopedic surgeons have worked hand-in-hand with robotic hip replacement specialists.

Technical Failure: There is always the danger that hardware and software alike can fail. A loose screw in a robot can render the device unusable, or a software malfunction in a Fetal Monitoring system can cause the data to be unacceptable. These are valid concerns in both a normal surgical operation or in a virtual-reality assisted telepresence surgery. But the fact remains that overall, the practice of medicine is prone to human errors. Mechanical failures, although unforeseeable, are often adjusted by providing redundant equipment or a fault-tolerance connection. It can be avoided with properly trained personnel, frequent calibration of equipment and implementation of an emergency backup plan. There is also the constant need to keep skilled technical staff and a need to train the medical community on how to effectively use the system. It is not an easy task but it has to be in place upon implementation and should be maintained if one has to keep up with the telecommunication technology changes.

Malpractice Suits: This is one of the major concerns with the new telemedicine technology. With telemedicine practice becoming more common, there are possibilities of an introduction of new legal soft spots in the healthcare community. For this reason alone, more physicians are alienated by the technology. In the United States, for example, the average physician has 37 percent chance of being sued at some time in his or her career. This increases to 52 percent for a surgeon and 78 percent for obstetricians.[1] Legal issues will always plague any medical procedure, but with telemedicine procedures there could be a more aggressive form of collecting data to support any malpractice suit. Dr. Jay Sanders states that: "For the first time, we're opening up communication modality as a potential source of misinformation. We now not only have a written record, we have a visual record, we have an audio record of the entire consultation."

Security: This is a main concern in any healthcare institution. Hospitals need to advocate patient confidentiality. With patient records having to traverse the information highway, telemedicine projects are faced with providing security measures to insure that none of the data will fall openly to malicious hands. Most hospitals offer two-level access controls for their telemedicine operators and administrators, one password for access to the server and another for the individual database. Also, the government came out with new policies to protect any patient information being sent out using the information highway.

TELEMEDICINE BACKGROUND AT THE UNIVESITY OF ROCHESTER, STRONG MEMORIAL HOSPITAL

The 750-bed Strong Memorial Hospital is the primary teaching hospital of the University of Rochester School of Medicine and Dentistry and School of Nursing. Further, it serves as the tertiary care hospital for the Finger Lakes Region of Upstate New York and has been designated by New York as the region's Trauma Center. In addition to its primary care services, the hospital offers a variety of specialized services including high risk obstetrics and gynecology; bone marrow transplantation; liver, kidney, and pancreas transplantation; magnetic resonance imaging; kidney stone lithotripsy; comprehensive pediatric care; a burn unit; and comprehensive epilepsy treatment. Strong Memorial hospital's affiliation includes more than 1,000 physicians and more than 6,000 other health care providers and support staff.

The business unit at the University of Rochester Medical Center (URMC) realizes that in order to maintain a leading edge as an academic and clinical institution, serious consideration must be given to procure telemedicine technology. An initial committee was formed in early 1997 to look at valid applications of telemedicine for Strong Memorial Hospital. Although there exists some telemedicine applications within the hospital, there has really not been a real application implemented involving remote accessing.

On June, 1994, a telemedicine task force convened to develop a vision for telemedicine at Medical Center. A demonstration was done between Strong Memorial Hospital and Noyes Hospital, in Dansville, which provided a first look on a telemedicine application. There was a time around March of 1995 when the Office of Rural Health Policy (OHRP) offered funding to evaluate telemedicine projects but the funding fell through. At that time, there was also a lack of faculty support in some required clinical specialties. By August of 1995, the United Medical Network was contracted to conduct a telemedicine assessment and recommend a network solution for 8 hospitals and 4 health care centers. Site visit was scheduled for October and a report done in November.

As early as December 29, 1996, a proposal was sent out to the New York State Advanced Telecommunications Project. The Strong Memorial Administering Remote Telemedicine (SMART) was to provide an Integrated Service Digital Network-Bit rate Interface (ISDN-BRI) connectivity to the southern tier hospitals of Western New York. The project was to consist of six regional hospitals namely, Soldiers and Sailors Hospital, Jones Memorial Hospital, St. James Mercy Hospital, Ira Davenport Hospital, Schuyler Hospital and URMC. The SMART project barely got off the ground but was replaced by another telemedicine initiative.

In June 1997, another proposal[5] was submitted to the committee outlining a telemedicine project involving the New York State Department of Corrections (NYSDOC). URMC was in a unique position to acquire telemedicine technology via a contractual agreement with NYSDOC to provide prison medical services. The telemedicine and video conferencing will enable URMC to manage inmate medical care in Western New York. The contractual agreement involves NYSDOC extending state pricing to URMC to purchase telemedicine and videoconferencing equipment. It will provide a 16 percent cost savings versus URMC having to purchase their own equipment (Appendix B).

Other goals for this telemedicine initiative were:

- To link several potential regional hospitals for grand round presentations (medical student sessions) and educational training. There is a high degree of regional physicians who are very interested in linking with URMC for Grand Rounds and other health related videoconferences or training.
- To provide clinical consults and patient triage - this implementation will enable physicians from an equipment-advanced hospital to assist physicians at rural or remote hospitals using medical video conferencing, medical history and image transmission.
- To enroll patients in clinical trials – some physicians feel that opportunities exist to enroll regional patients in acute stroke protocols via telemedicine. There are also interests in opening discussions around clinical protocol enrollments.

- To provide administrative conferencing – the telemedicine implementation will provide cost benefits on several institutional collaboration.

The NYSDOC agreement for telemedicine application will strengthen URMC's ability to build a coalition with other regional partners. Out of 26 surveyed regional institutions, 12 institutions indicated a presence of a telemedicine application or pending grant. Below is a list of the 26 potential regional partners:

- Arnot-Ogden
- Batavia VA Hospital
- Bath VA
- Canandaigua VA
- Cayuga Medical Center in Ithaca
- Clifton Springs
- Corning
- Cuba Memorial
- F.F. Thompson
- Genesee Memorial
- Geneva General
- Ira Davenport
- Immogene Bassett Cooperstown
- Jones Memorial
- Lakeside Memorial
- Medina Memorial
- Myers Community
- Newark-Wayne Community
- Nicholas Noyes Memorial
- Olean General
- St. James Mercy
- St. Jerome's
- St. Joseph's
- Schuyler

- Soldiers & Sailors
- Wyoming Community

The URMC and NYSDOC telemedicine project will also foster a more personal relationships and acquaintances between healthcare professionals. It will also impact patient referrals by enabling physicians to interact face-to-face with their colleagues within the region without leaving the hospital.

In November of 1997, a Request for Proposal was sent out to other medical departments in the hospital. Each department is welcome to submit their telemedicine projects to the telemedicine committee. Several departments responded to the RFP with promising projects of telemedicine implementation from surgery to psychiatric applications (Appendix F).

The groundwork has been laid for the first telemedicine implementation at Strong Memorial Hospital with hopes that the project will evolve to wider use. With the aid of the growing telecommunications technology, and the collaborative work with the NYSDOC, telemedicine will be on its way to improve the quality of healthcare not only for the inmates but for the rest of the region.

TELEMEDICINE BACKGROUND AT THE NEW YORK STATE, DEPARTMENT OF CORRECTIONS

For many years the prison healthcare system has been using several telemedicine applications. From a recent survey, 4 out of 10 most active telemedicine initiatives were based on prison care. Again, for the prison system telemedicine presents a strategic, cost-effective tool in delivering healthcare to prison inmates. As more people are incarcerated for longer periods of time, there has been an increase of demand in healthcare services for inmates.

The University of Texas Medical Branch at Galveston and the Texas Department of Criminal Justice jointly operates the second-most-active telemedicine program in the United States. They logged 3,4000 patient/clinician interactions in 1997 and more than 1,000 in the first quarter of 1998. The third-most-active telemedicine program in the country is based in Columbus, Ohio. The Ohio State University and the Department of Corrections jointly runs the telemedicine project, logging 2,613 clinical interactions in 1997 and more that 750 in the first quarter of 1998.

The New York State Department of Corrections also has a very active telemedicine application. It delivers healthcare to over 70 correctional facilities dispersed throughout the New York State. Many of these facilities are in the rural areas, which requires medical, educational and legal services.

elow is a chart, provided by the NYS/DOC, which shows the current inmate population and a projected population up to year 2001.

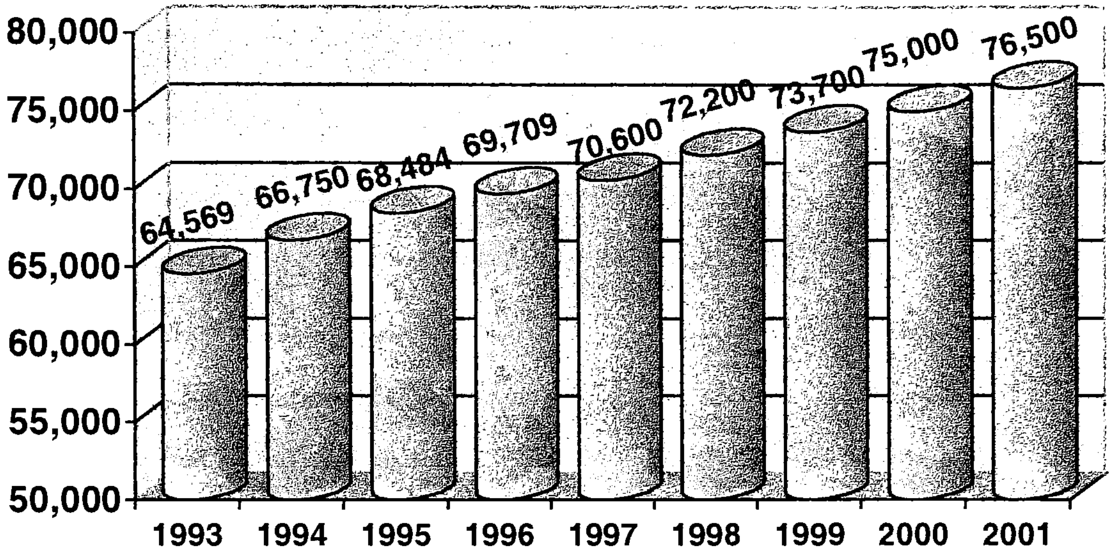


Table 1. DOCS INMATE POPULATION
1997–2001: Figures are projected
2000-20001: Applicable if capacity is approved by the Legislature

With such a projected inmate population, the demand for medical, education and legal services also increases. Provisioning for video conferencing the NYS/DOC can provide travel expense savings, time savings, overtime expense savings, public and staff safety and also access to otherwise unprovided services, i.e. staff training or regional seminars. Currently, the NYS DOCs is responsible for health care of 70,000 inmates held in 70 state correctional facilities. The DOC employs 1,400 primary care staff and has approximately 1 Million primary care encounters per year. It also encounters 69,000 specialty care cases.

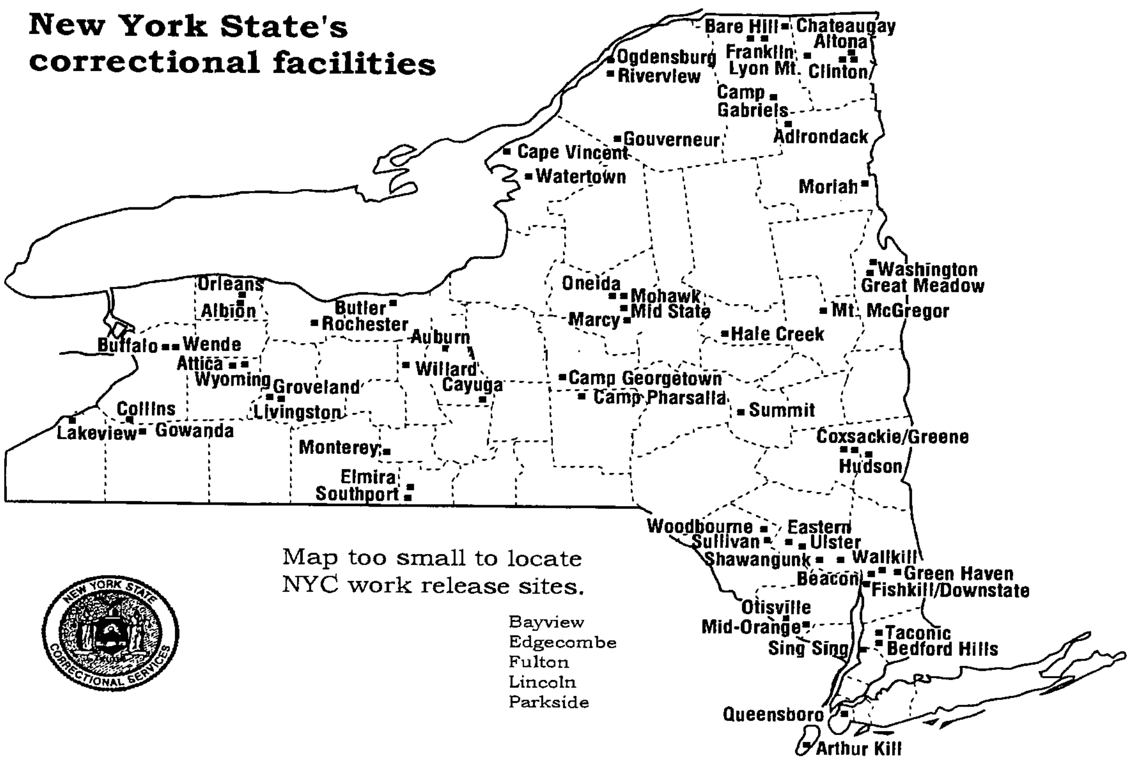


FIGURE 1

Telemedicine increased the specialty care encounters. It reduced the necessary trips that the inmate has to do to the regional hospitals to access healthcare services, primarily emergency and specialty care consultation.

The NYSDOC implemented a seven-month period Telemedicine Pilot project in 1995. The project started with emergency consult with 212 inmates identified as patients appropriate for telemedicine screening.

The following results were collected during the pilot period:

- 96 inmates were screened
- 28% of the inmates had needs met through telemedicine
- 36% went to the hospital and returned to the correctional facility
- 35% were admitted to the hospital, many of which used "Direct Admits" to reduce or eliminate waiting times

The telemedicine pilot also included specialty care consults with 46 recorded specialty care consults during the pilot period. Each consult represented a trip saved to the hospital or specialty care clinic.

The telemedicine pilot also yielded five educational programs and four administrative meetings. There was a total of 73 trips to different institutions saved during the trial. Unfortunately, due to the varying length of each trip, manual reporting instruments and the different inmate security classifications, dollars saved was not calculated during the telemedicine pilot.

The NYSDOC had initially coordinated specialty care with four regional healthcare institutions namely:

- Western NY – Strong Memorial Hospital
- Central NY – SUNY Health Sciences Center
- Northeastern NY – Albany Medical Center
- Lower Hudson – which is still to be named

Some of the identified services that the above-mentioned institutions will provide includes medical triage of emergency patients, pre-admission testing i.e., for Anesthesia, specialty evaluations such as dermatology and Infectious Disease, and staff training. To date, the NYSDOC has academic and medical partnership with several other institutions.

Figure 2 shows the actual map of the NYSDOC Telelmedicine Hubs:

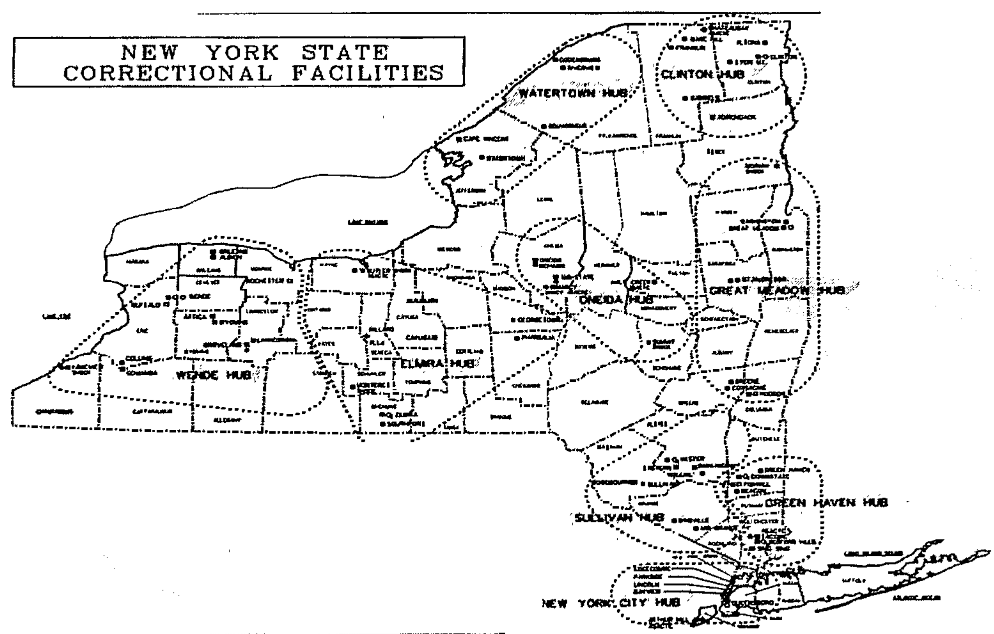


FIGURE 2

Each hub represents the areas covered by each telemedicine site. Areas include maximum, medium, and minimum, security prison. It also included minimum security camps, mental health facilities, and alcohol and substance abuse correctional treatment centers.

PROJECT DESCRIPTION AND METHODOLOGY

This telemedicine project gave the University of Rochester Medical Center a unique opportunity to be involved with a well-recognized telemedicine application. It will provide URMC the ability to build on strategic alliances with the other hospitals and institutions within the region and maintain our position as a leading tertiary institution in Upstate New York. URMC has the potential to be the first Rochester hospital to establish a link between 12 regional institutions that has an existing telemedicine technology or grants with pending approval.

The telemedicine project will allow the hospital a means to provide real-time medical consultations, view highly detailed images, enroll patients in clinical trials, and conduct educational and administrative video conferencing. It will also provide positive impact on patient referrals by allowing URMC physicians to interact face-to-face with their regional colleagues without leaving the hospital.

PARTICIPANTS

For this telemedicine implementation, the network project team included technical staff from the University of Rochester Medical Center, New York State Department of Corrections and Frontier Corp.

The following technical staff were involved with the planning and implementation of this telemedicine project:

Jeannie L. Christensen - Senior Communications Analyst/Network Engineer, Strong Memorial Hospital

John DeSocio – Telemedicine Coordinator, Media Center Strong Memorial Hospital

Cathy Hoercher – Project Manager, University Telecommunications Division, University of Rochester

Douglas Bentley – Senior Network Engineer, University Telecommunications Division, University of Rochester

Mike Myers – Lead Network Engineer, Strong Memorial Hospital

Linda Powell – Telemedicine Coordinator, New York State of Corrections

Doug Miller Frontier Corp. Technician who was responsible for the T1 circuit provisioning, testing and diagnostics.

REQUIREMENTS AND SPECIFICATION

The main network design goal is to provide a high-speed telecommunication bandwidth between URMC and Albany NYSDOC Office. The Albany site served as the "hub site" to the other correctional facility that were part of the trial network., i.e., Albion Correctional Facility, Attica Correctional Facility, Collins Correctional Facility, Groveland Correctional Facility, or Wende Correctional Facility.

The NYSDOC contract required that the URMC network be operational with the telemedicine services by April 1, 1999. The project is challenged by the need to leverage our new ATM Backbone as well as the Internet connection to deliver video, voice and data to the NYSDOC sites.

The requirements included purchasing two PictureTel Concorde 4500 units, which is in line with the equipment that NYSDOC uses in their telemedicine sites. The preferred transmission system by the NYSDOC is a point-to-point T1 circuit between the NYSDOC Albany office and URMC. This is also what they have used on all of their other telemedicine sites.

COSTS

It has always been difficult to justify an experimental medical project. In the telemedicine arena, cost was an important factor to consider. To fully understand the actual cost to implement the project, the committee had to break down the specific components necessary. Appendix A details the two options for capital and operating costs. It shows the cost if NYSDOC were to absorb some of the cost and if URMC shoulders all of the cost. There is a noticeable difference on the rate for capital expenses due to the fact that NYSDOC gets a much lower pricing from the PictureTel vendor.

The costs for the installation and circuit are comparable. Please note that there is a minimal cost difference from the day the proposal was submitted to when the final project was implemented. It affected the T1 circuit recurring costs and the "per call" costs.

Since it's inception, emergency tele-consultations have been the focus of the project therefore the Emergency Department will be one of the target location for the PictureTel equipment. The emergency department needed to be equipped with a special room to house the equipment. It will also be used for the clinical consultations. A room has been identified for this purpose but it will have to be renovated.

Another cost issue is the "per call" cost. URMC will not incur any per-call costs when conducting consultations, patient triage and educational sessions as long as the call is initiated by the NYSDOC. Interaction with other regional institutions will incur "per call" expenses, as follows (please refer to Appendix A for the cost breakdown):

- For two-party calls, URMC will dial the institution and will be billed a per minute/channel cost. For example, if URMC dials Groveland Correctional Facility, at $0.57 per minute/channel, a 15 minute call will cost URMC $10.26.
- A multi-way conference, which would be 3 institutions or more per call, will be initiated by MCI. URMC will be charged for the per minute/channel costs, the bridging costs, and the gateway service charges, if applicable. Bridging costs applies if there are more than two parties in the videoconference. Gateway service charges applied if the institutions in the videoconference are not on the MCI dialing plan. A 60 minute three-way call initiated by URMC will cost approximately $417.96

There was also a recurring cost for the T1 circuit, which included the circuit maintenance and the access loop from the terminating central office (CO) to the URMC main switch room at the Annex.

Other ancillary expenses included the training costs for two Media Center personnel on how to use and support the video conferencing equipment. These two Media center staff provided training, inservicing and is currently the primary source for conference set-up. Below is a cost summary projected for the first year inclusive of the start-up costs:

Initial Startup Cost		
ITEM	**NYS DOC Pricing**	**Without NYSDOC**
Equipment	$96,816	$114,800
Installation	2,940	2,940
Renovation	3,685	3685
Training	3,600	3,600
Total	$107,041	$125,025
Projected Annual Operating Costs		
Access Loop and Maintenance	$5040	
Regional Linkages (consults and conferences)	$41,191	
Total	$46,231	

FIGURE 3

IMPLEMENTATION

As mentioned before, since this is a telemedicine pilot project, the initial goal is to provide emergency consultations. Therefore, one of the PictureTel 4500 units will be housed at Strong Memorial Hospital Emergency Department with the main function of providing clinical consultations and for patient triage of inmates and patients located in other regional institutions.

The original plan was to use the second unit as a roaming unit and will be stationed in the third floor of the medical school at URMC. The location is at the Media Center (Room 3-7511). It was supposed to be used for four strategically located conference rooms but it was not satisfactory for some of the URMC departments. Due to staffing issues, some departments need access to a roaming unit in some other locations closest to their area. It was a unanimous decision to add several more potential rooms where the roaming unit can be transported and connected to the network. It will be transported to any of the following locations:

- Whipple Auditorium (2-6424)
- Class of 62 Auditorium (Medical Research Building)
- K-207 (2-6408)
- K-307 (3-6408)
- Upper and Lower S-Wing Auditorium (3-7619)
- Ambulatory Care Facility Rooms A,B,C,D,E (2-1362)

- Ambulatory Care Facility Board Room (2-1322)

- Orbison Room (1-5421)

STANDARDS AND PROTOCOLS

The quality of compressed video varies depending on the specific standard and bandwidth being used. The primary protocol for the voice and video communication was another important factor that needed to be resolved. The NYSDOC is using H.320 and which we ended up using at the time the project was fully implemented. The H.320 protocol is a switched-based protocol and it provided us with a point-to-point physical connection. The H.323 protocol is packet-based and uses TCP/IP as its main transport system therefore would have been able to coexist with our current ATM backbone. The NYSDOC contract did not provide any flexibility on the protocol that we can use.

Currently, we are still struggling to use H.323 and are running across problems with the current equipment not being compliant to the newer standard, which is discussed further on the next chapter.

We will not discuss these protocols in depth, but it is necessary to explain why it was a standard protocol of choice and what other protocols or standards are available for audio and video transmission.

The H.323 protocols, which are regulated by the International Telecommunications Union (ITU), is an "umbrella" for a set of standards that defines real-time multimedia communications for packet-based networks.

Much of the excitement surrounding H.323 protocols involves their enabling H.323 entities to communicate over the Internet or managed Internet Protocol (IP) networks. The standards under the H.323 umbrella define how components that are built in compliance with H.323 can set up calls, exchange compressed audio and/or video, participate in conferences, and interoperate with non-H.323 endpoints.

The H.320 recommendation governs the basic video-telephony concepts of audio, video and graphical communications. It specifies the requirements for processing audio and video information. It also provides common formats for compatible audio/video inputs and outputs and protocols that allow a multimedia terminal to utilize the communications links and synchronization of audio and video signals.

This recommendation specifies technical requirements for narrow-band visual telephone systems and terminal equipment, typically for video - conferencing and videophone services. It describes a generic system configuration consisting of a number of elements which are specified by respective International Telecommunications Union (ITU) recommendations. Such elements included the definition of the communication modes and terminal types, call control arrangements, terminal aspects and internetworking requirements. Some of the revisions to this recommendation are reflected in relevant H-Series recommendations such as H.262, H.263, H.310, H.322, H.323 and H.324. Below is a list of the Multimedia Teleconferencing Standards Recommendations in force today: [12]

Video - These standards specify methods of video compression and communication.

- **H.320** - Narrow-band Visual Telephone Systems and Terminal Equipment. ISDN (Integrated Services Digital Network) video conferencing
- **H.323** – LAN based video conferencing
- **H.324** – POTS (Plain Old Telephone Service) modem based video conferencing
- **H.221** - Frame Structure for a 64 to 1920 kbit/s Channel in Audiovisual Teleservices
- **H.261** - Video Codecs For Audiovisual Services at Px64 Kbps HTML
- **H.230** - Frame-synchronous Control and Indication Signals for Audiovisual Systems
- **H.231** - Multipoint Control Unit for Audiovisual Systems Using Digital channels up to 2 Mbit/s
- **H.243** - System for Establishing Communication Between Three or More Audiovisual Terminals Using Digital Channels up to 2 Mbit/s

Audio - These standards specify methods of compression and communication for the sound contained in a video conference.

- **G.711** - Pulse Code Modulation (PCM) of Voice Frequencies; provides telephone quality audio (narrow band, 3.4 kHz)

- **G.722** – wide band, 7 kHz Audio-coding Within 64 kbit/s; provides stereo quality audio
- **G.723** – Algorithm for compressed digital audio over POTS lines. It is used with H.324.
- **G.728** - Coding of Speech at 16 kbit/s Using Low-delay Code Excited Linear Prediction; provides audio for low bandwidth calls (16 kbps)
- **G.729** – Voice algorithm (CS-ACELP: Conjugate Structure Algebraic Code Excited Linear Predictive) for coding speech signals in telecommunications networks

It is unfortunate that we were not able to leverage the current network for our telemedicine implementation. We have hopes that within a year or two the migration to H.323 would happen. Like the other multimedia teleconferencing standards, H.320 can be applied to multi-point and point-to-point sessions over circuit switched services like ISDN or Switched-56.

NETWORK DESIGN

After several committee meetings, the team divided the NYSDOC/URMC project into two phases. This way it would be easier to implement and monitor the task on hand.

Phase 1 will touch upon the network design which included procuring the T1 circuit, determining the demarcation line, extending the circuit to the URMC Media Center Studio, planning for horizontal wiring for the Emergency room and individual conference rooms. Renovation of the emergency room was also ongoing during this phase.

Phase 2 will focus on the deployment of the telemedicine equipment, provisioning the T1 circuit and doing some testing. Phase 2 also included the administrative team's activities. In order to develop linkages with the regional hospitals there will be a team that will visit each institution and conduct a demo on linking with URMC for conferencing and consultations. Additionally, the team will also consider other post implementation issues such as overall cost (inclusive of the recurring expenses) and usability of the telemedicine project.

PHASE 1:

We started with Phase 1 by doing a site survey of an existing network in one of the New York State correctional facilities. Linda Powell, NYSDOC coordinator, chose Attica Correctional Facility, Attica New York because of its location and that it has an extensive telemedicine network implemented. I went alone and met Linda Powell at a nearby hotel. That was my first time inside a correctional facility and didn't know what to expect. Upon entering the facility, it was necessary to go through heavy security check. It was very organized and systematic. I was led to the Administrative Offices where they house their telemedicine equipment.

One of the smaller rooms contained the facility's network devices. I learned that their normal setup would consist of a T1 line terminated into a Channel Service Unit/Data Service Unit (CSU/DSU) and then to a Cisco router. There is also a modem connected to the router for remote diagnostics and maintenance. They are using Category 5 unshielded twisted pair cable for the room wiring.

During the visit, an actual video conference call was made to Albany to discuss the some of the other details we will need for the URMC network design. I was able to observe a demonstration on how some of the telemedicine equipment will be used for an actual patient consultation and the clarity of both video and voice transmission. Some of the telemedicine peripherals included a forms document reader, an x-ray reader, otoscope (for the ears), ophthalmoscope (for the eyes), dermascope (for the skin). For this telemedicine application, we purchased an ELMO document reader. (Refer to Appendix A for the Budget Proposal.)

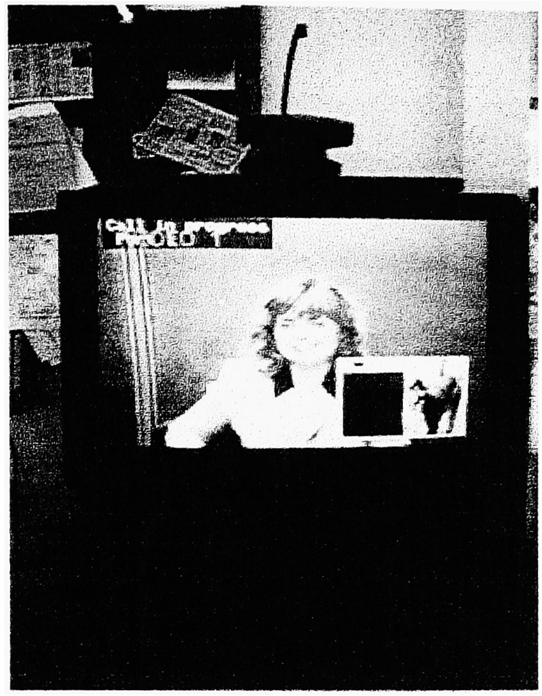


Photo 2: Linda Powell in an actual video conference from Albany, New York. The picture-in-picture is the URMC side.

A key component that was relevant to our network design was network fault tolerance. Our intent was to offer connectivity with very minimal or no downtime and define a protocol for maintenance and support of the network.

Our goal was to connect the NYSDOC to the URMC network via a wide area network and connect it to the hospital's local area network, providing voice, video and data service, with relatively high level of support and quality of service.

The NYSDOC has an existing contract agreement or dialing plan with MCI for their circuits. It was to URMC's advantage if we use the same service provider. All administrative and maintenance support would be through MCI although part of the wide-area network's physical layer used Frontier Corp.

and Time Warner Communications. Our decision to procure a T1 circuit from these service providers was pre-determined by the NYSDOC contract with the vendor. The T1 circuit provided the bandwidth of 1.544 megabit T-carrier channel that can handle 24 voice or data channels at 64 Kbits/sec. A standard T1 frame is 193 bits long, which can hold 24, 8-bit voice samples and one synchronization bit. It would be transmitting 8,000 frames per second. Six channels were dedicated for NYSDOC use, and another six channels was earmarked for video conferencing. There will be 12 idle channels that will be used for scalability. It will be available for use in the event that URMC decides to purchase additional video conferencing systems.

The T1 line is originating from an MCI LEC and will co-locate with the central office for Time Warner and Frontier Corp at Fields Street (Figure 4). The demarcation line will be at the main switch room at the Medical Center Annex located at Elmwood Avenue.

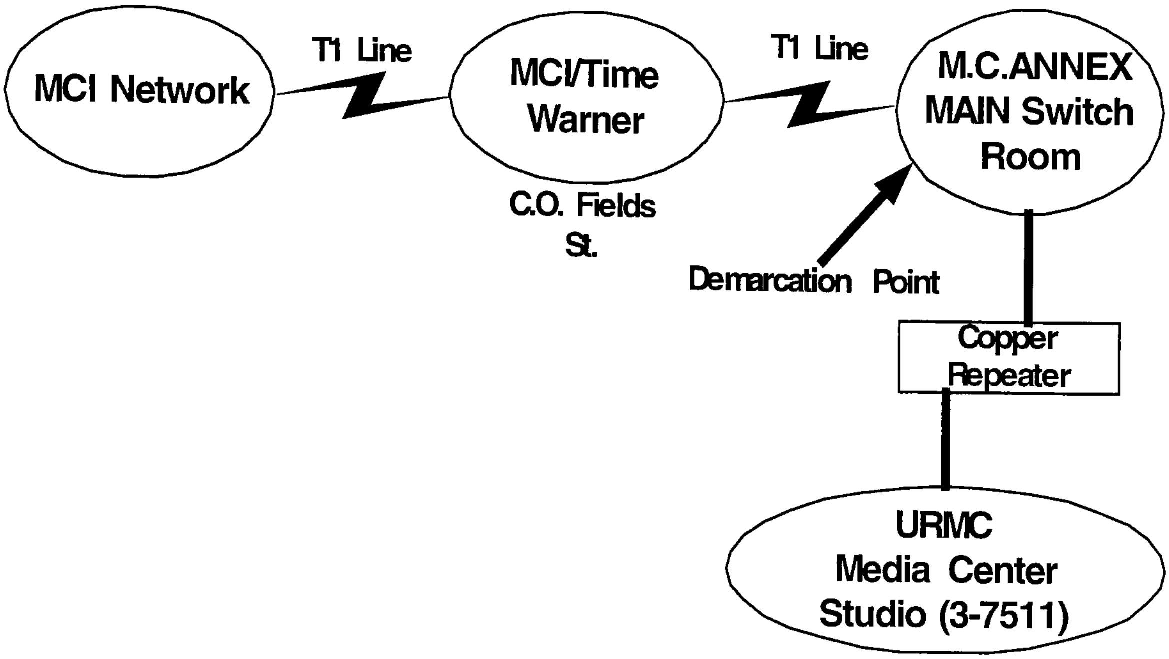


FIGURE 4: Wide-Area Network Topology

Figure 4 illustrates the building-to-building physical wiring for the telemedicine project. It shows how we extended the T1 line from the provider demarcation line to the customer premise's termination line.

Previous to this project, a multi-mode fiber connection was installed from the Media Center Studio to the Medical Center Annex. It was originally allocated for a telemedicine initiative that did not materialize. Photo 3 shows the logical interface unit (LIU) that is in the Media Center Studio. For this project we used two fiber strands to extend the T1 line from the Medical Center Annex to the Media Center Studio location utilizing a copper repeater in between as a signal booster.

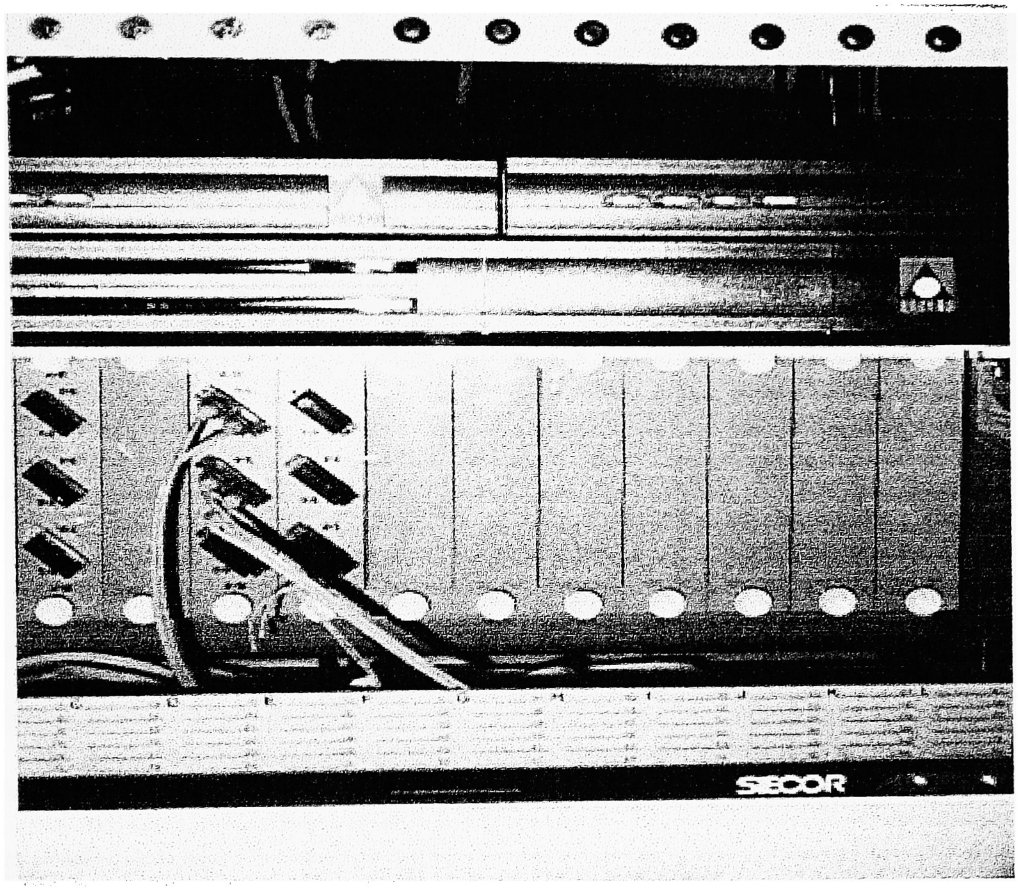


Photo 3: Top devices are the 2 Ascend RPMs and one Ascend Multiplexer; bottom device is the Fiber Logical Interface Unit. All equipment are located in the Media Center Studio (Room 3-7511).

The equipment used for the termination of the T1 circuit had to comply with the NYSDOC's equipment requirement. We had to use the Ascend Multiplexer (IMUX) and the Ascend Multiband Remote Port Module (RPM) since it was widely used and are compatible with the NYSDOC. The RPM is essentially another signal booster.

It is beyond the scope of this project to go in depth on the proprietary equipment but I do believe that a short definition of the devices is necessary.

The Multiband VSX T1 is a compact, scalable inverse multiplexer that can establish group or desktop videoconferences at speeds ranging from 112 Kbps up to a full T1 (1.55 Mbps) and can be expanded to handle simultaneous voice and video traffic over the same T1 line. It optimizes dial-up bandwidth and came with a built-in CSU/DSU which eliminates the need for a stand-alone unit. It could also be configured either locally via a console port or remotely for easy diagnostics and management.

The Multiband RPM is a self-contained port extension device that allows the Ascend IMUX to communicate over regular copper wire and the existing data jacks instead of running special wiring. It extends the functionality of the IMUX up to 3,400 feet. The Ascend IMUX acted as a CSU/DSU as well.

We needed four RPMS: two RPM's was located at the Media Center Studio, the would act as the receiver for the other remote RPMs. The third RPM will be with the PictureTel unit at the Emergency Department, and the last RPM will go with the roaming PictureTel unit. We connected the T1 line to the CSU/DSU in the Media Center Studio that was a built-in component of the Ascend IMUX. It came equipped with RJ-45 ports to accommodate 4 RPMs. Photo 4 shows the Ascend IMUX and the RPMs. We used a Fiber-to-RJ45 transceiver to connect the Ascend IMUX to the Fiber LIU. Photo 4 shows the final termination of the T1 line to the Ascend IMUX.

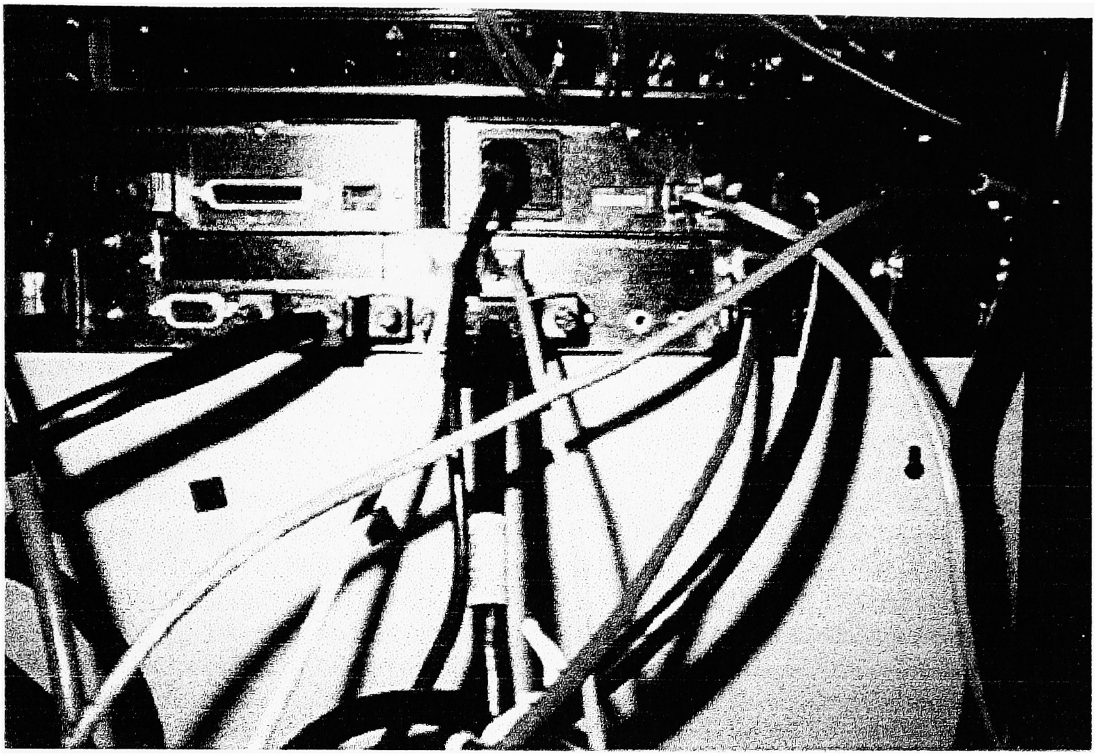
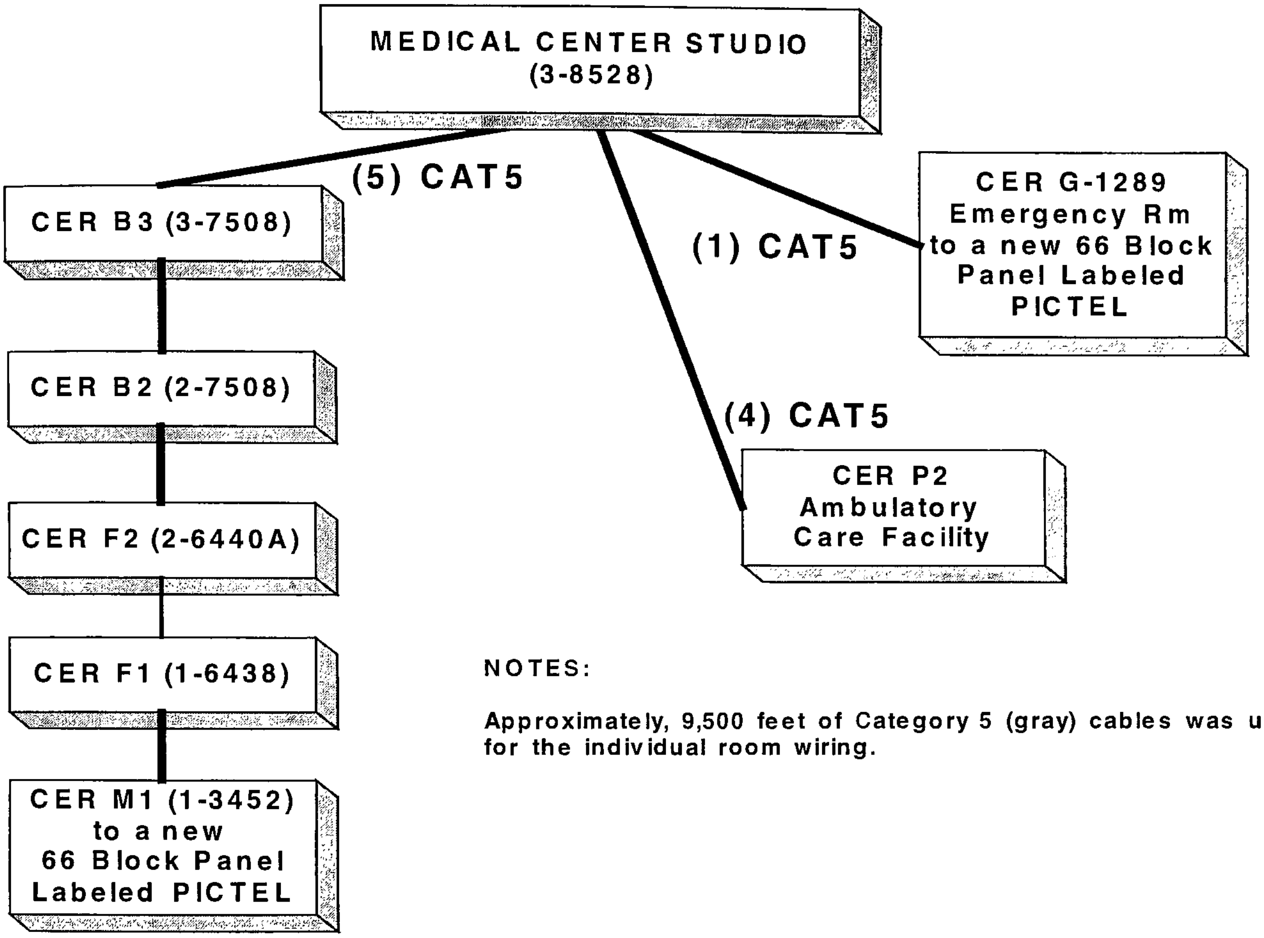


Photo 4: Back of Ascend IMUX (bottom) and the Ascend RPM's (top)

We now come to the physical wiring for the room location. As previously mentioned, there were two main locations for the 2 PictureTel Unit, one in the Emergency Department, and the other would be used as a roamer for different conference rooms (Figure 5). From the Media Center Studio location we ran Category 5, unshielded-twisted pair cables to the identified conference rooms and one to the Emergency room. The RPM's provided us with 3,400 feet limit for our Category 5 cables. The Cat5 cables will be terminated in different computer equipment rooms (CERs).

FIGURE 5

Pulled several Category 5 (gray) cables from 3-8528 to the different Computer Equipment Rooms (CERs). Below is the cable path all over the hospital.



NOTES:

Approximately, 9,500 feet of Category 5 (gray) cables was used for the individual room wiring.

Figure 5 illustrates the physical cabling run from CER-to-CER location. All of the above-mentioned conference rooms and auditoriums needed physical wiring to the nearest computer equipment room (CER). Again, we cannot exceed our 3,000 feet limit with the Repeater Port Module (RPM) therefore it was necessary to shorten the cable run to different to the nearest CER. Each cable wiring was tested and certified by the University Telecommunications Division.

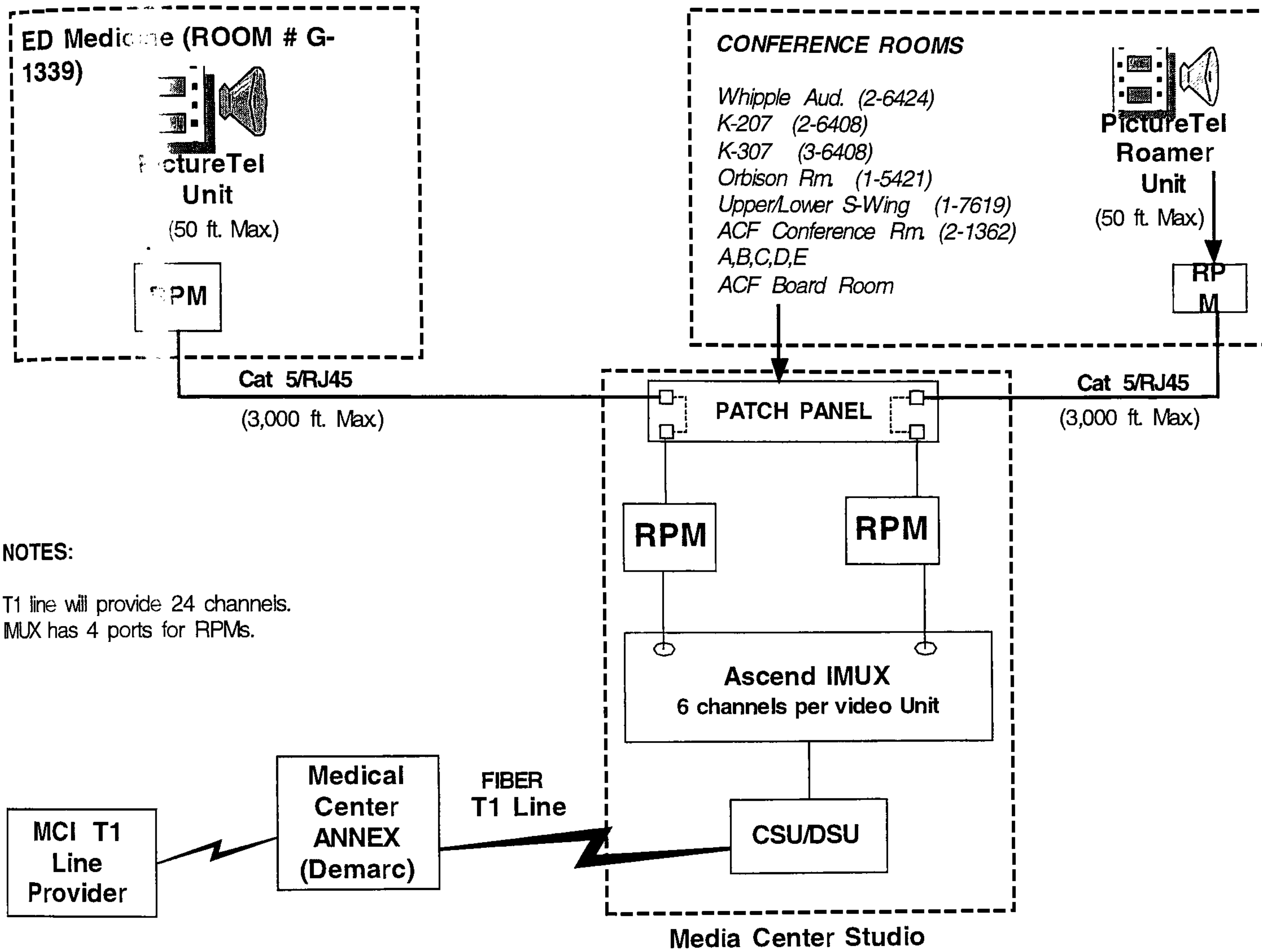


FIGURE 6: URMC Telemedicine Network Topology

All of the above-mentioned conference rooms and auditoriums will need physical wiring to the nearest computer equipment room (CER). Figure 6 illustrated how the overall network would be implemented.

The initial network design was further complicated by the distance from the individual conference rooms, particularly the Ambulatory Care Facility

(ACF), and the URMC Media Center Studio. There are five conference rooms in the ACF that needs Cat5 wiring to access the PictureTel IMUX. There were three design options that was considered:

1) Run a Cat5 cable from the Media Center Studio to the CER B2 and from there use existing fiber cables to the ACF building CER. This design needed some fiber to copper repeaters along the path which raised the implementation cost.

2) Run Cat 5 cables from the Media Center Studio to CER M1. From there we can daisy chain each conference rooms. This design exceeded the limitation of 3400 feet.

3) Use a start topology and home run each conference rooms to the closest CER. The individual conference rooms were then wired to nearest individual CER.

We decided to go for option 3 because of the cable length limit. We wanted to keep the wiring cost at a minimum. We used 9,500 ft of Cat5 cable and the total cost was approximately $7,000 (inclusive of labor) and was within the budget.

It took over a month to procure the T1 line and less than two weeks to finish the cabling.

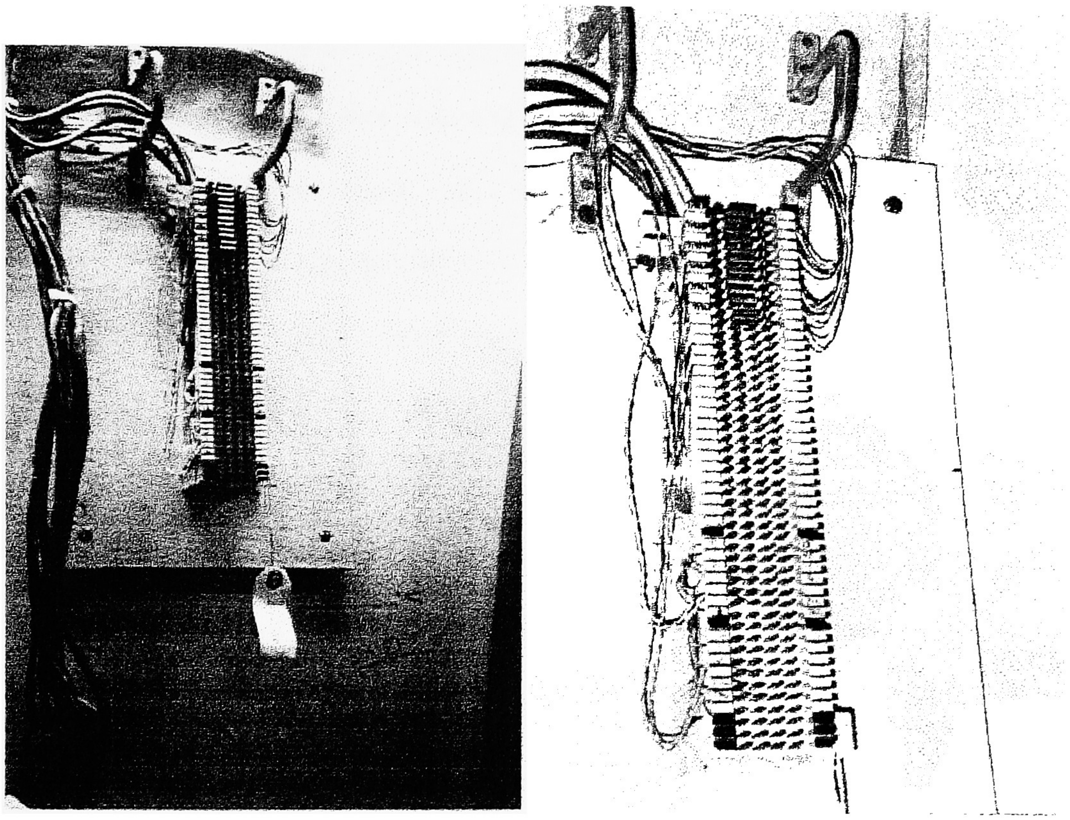


PHOTO 5

Photo 5 shows the punch block we used for the Category 5 room-to-room wiring. The one on the left is computer equipment room (CER) in ED and on the right is CER M1.

PHASE 2:

While Phase 1 was ongoing, John Desocio and I were also busy training ourselves on how to use the PictureTel units. Mr. DeSocio went for the PictureTel training, as planned. There was a budget for it and he was the one that will be mostly interacting with the system as soon as we have the telemedicine application successfully implemented.

As soon as we had the T1 line extended to the Medical Center Media Center Studio, we began installing the Ascend equipment. This was when we discovered that the Ascend IMUX was the wrong component because it did not come with the correct number of ports. We had to have one shipped to us in relatively short time. Upon delivery of the correct Ascend IMUX, John Desocio and I used the recommended test transmission by the vendor and were successful. The T1 line was terminated by Frontier instead of MCI. A local Frontier technician assisted us during the line test.

We had to wait until after the T1 circuit has been provisioned before we could configure the PictureTel unit with the proper circuit channel numbers (almost like a local phone number to dial).

There were two parties involved with the final testing phase. The near end, located at the URMC and the far end, which would be the Albany NYSDOC Administrative office. Even if we have two location with two PictureTel unit, both will be consider the near end unit.

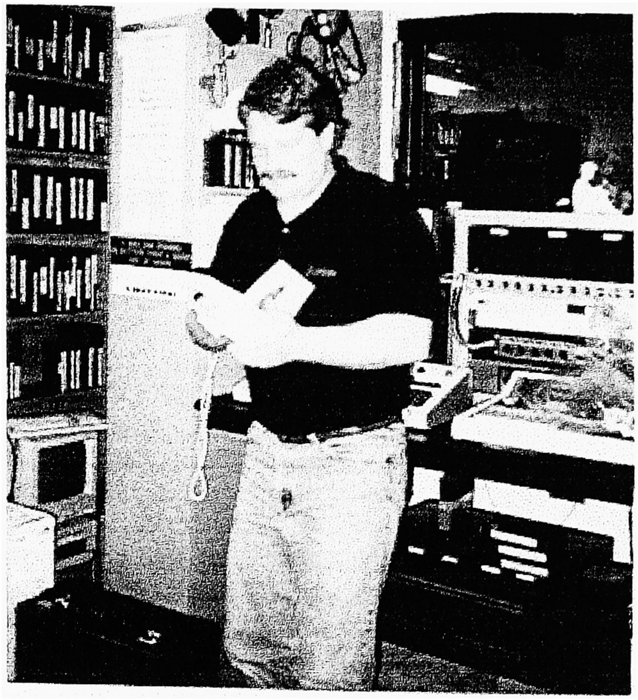


Photo 6: The team started provisioning the line with the assistance of Doug Miller, Frontier Corp. technician.

We then proceeded with the T1 circuit testing. We ran across a problem on the transmission test but found out that the circuit was unknowingly left on diagnostic purpose on the vendor side. It took one phone call to the service provider to remedy the situation. The T1 line was configures as follows:

No. of Channels per video unit: 6 channels, with total 12 channels for the 2 video device we purchase. One for the ED room and one to function as a remote unit.

Channel 1 – 6 was given a local number of #3021400

Channel 7 – 12 was given a local number of #3031400

Channel 13 – 18 idle

Channel 19 – 24 idle

Signaling Mode: Inband

Framing Mode: D4

Line Encoding: AMI, standard loop

Facilities Data Link (FDL): None

Rob Ctl: Idle Start/No wink

It took us a day to provision the line and we decided to postpone the actual transmission to Albany until the next day.

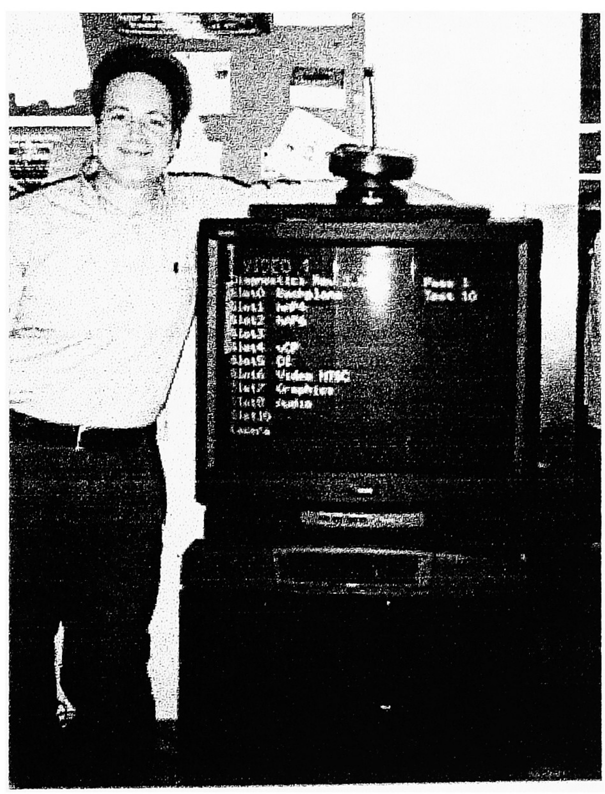


Photo 7: John Desocio with the actual telemedicine PictureTel Unit at the Emergency Room at URMC

With the T1 circuit properly configured and tested, John Desocio was able to configure the PictureTel Unit with the actual channel numbers. We tried to connect to the NYSDOC Albany office to do our first video conference but was unsuccessful. We encountered two problems.

First, we had a noticeable latency problem. The video and audio transmission was not quite synchronized. After further test on the circuit, we discovered that we had a bit error rate failure.

Second problem was the frequent disconnection. We ended up changing some of the PictureTel unit's configuration and mirrored the configuration that the far end unit was using. We did several more test session with Albany after fixing all of the configuration problems.

After our successful sessions with the NYSDOC office in Albany, we then requested for Jones Memorial Hospital to participate in an actual video conferencing with us.

The test was again successful and we proceeded with setting-up the second PictureTel unit as a roaming unit and applied the same test procedures we did with the ED unit. There were a couple of rooms wherein we could not get a successful transmission. Even if it passed the test, it turned out that we had a cross-wiring in one of the conference rooms and the second was damaged due to a recent renovation.

DISCUSSIONS, OUTCOMES, MEASUREMENTS

Although my primary role was to design the wide and local area network for the URMC telemedicine project, I was also exposed to the other issues involving the implementation, i.e., the logistics of providing medical diagnosis, billing issues and other administrative overhead. I attended some meetings where the following issues where also discussed aside from network connectivity:

- Because it is not a routine medical consultation by the emergency room billing by physicians for services will also be different. The general billing codes will sometimes not apply on the telemedicine consultation. A new billing structure was developed to accommodate these issues.
- We have to determine the logistics on filling up patient forms that would be necessary for the consult, such as consent forms, assessment forms and referral forms.
- Physicians will have to be available in both the near and far end.
- Video taping the patient session has always been available. There should be a presence of a document camera, medical peripheral camera and the external camera. This also touched upon patient confidentiality.

A key feature of telemed[illegible]ne systems, which distinguishes them from simple videoconferencing sy[illegible]ems, is the use of **peripheral devices**. These enable the clinician to have [illegible] better approximation of an on-site physical examination. This will inclu[illegible] electronic versions of standard examination tools (stethoscopes, otoscopes, ophthalmoscopes) as well as other 'sense extending' implements that are almost exclusively electronic, such as close-up cameras and document stands, dermascopes, and microscopes. These are the tools that might be most useful in a multi-specialty telemedicine practice. There is a wide range of electronic tools specific to various specialties like cardiology, dermatology, ophthalmology, and radiology. [13] Such tools were not available when we first tested the telemedicine project and further assessment of the need for particular tools had to be done.

The lack of billing structure was quite a concern. This issue took several months to resolve due to its legal and political implications. The NYSDOC has a contract with the Center for Disease Control Prevention (CDC) for it's administrative and billing procedures. Although there was a structure that could have been adopted, certain issues had to be considered such as specialty consult fees and referral fees.

Upon finishing the NYSDOC/URMC telemedicine project, I had very little interaction with the telemedicine team. I decided to seek some results and usability information for this project. I recently had the pleasure of discussing the current telemedicine application with Dr. Mary Gale Mercurio, Chief Physician for the Department of Dermatology at Strong Memorial Hospital. Mr. John DeSocio, who is now the Director for the Telemedicine Initiatives at Strong Memorial Hospital, was also present during the interview. They were able to provide me with some insight on how the Department of Dermatology uses the telemedicine application.

Dr. Mercurio uses the PictureTel and other telemedicine equipment that are part of the initially implementation. She has patient consultation at least three times a week. She manages to see inmates for approximately 12 hours per week with a minimum of an hour per inmate session. It is estimated that she averages 45 to 48 patient sessions per month. From the previous chapter, we have determined that the average cost savings for a telemedicine application could be at least $157.00 per session (refer to section on reduced cost). This equates to a cost savings of $7,536.00 per month or $90,432.00 per year. This cost savings is for the Department of Dermatology alone and does not include other departments such as the Emergency Room consultation.

I also asked Dr. Mercurio if there has been an instance where the telemedicine session did not workout for her. She said that every one of her patient sessions were successful except for one patient. The inmate was happy with the treatment but that he felt he was "short-changed" possibly due to the fact that the inmate was not able to travel outside of the prison.

When asked about the diagnostic accuracy and medical procedures, she said that it's just as if the patient was there, except that she really can't do the actual procedures. After offering the diagnosis, she relies on the far end medical staff to provide the necessary treatment. She provides medical diagnosis and the necessary prescription drug, if necessary.

Dr. Mercurio has to rely on the assistance of John DeSocio for setting up and assisting her with the medical peripherals during the consultations.

According to Mr. DeSocio, technical assistance is a matter of personal preference. Some physicians prefer that he sets up the consultation and walk out of the room. In Dr. Mercurio's case, she doesn't mind his presence and the patients are made aware of this.

Not every correctional facility is outfitted with the best telemedicine equipment. Some institutions do not have digital cameras therefore the image resolution is not as good. Dr. Mercurio was able to make headway by utilizing some light device, such as a built-in light on the camera, a lamp or flashlight.

After discussing the URMC telemedicine project with Dr. Mercurio, I can safely say the there is a great need for compilation or a study on the clinical outcomes and cost-benefits for every telemedicine implementation. There is also a need to have a primary repository for these studies, readily accessible to medical staff or even students. Documentation of the benefits of telemedicine can help with future request for funding requirement, medical research, and other issues that a regular medical consult would have.

Based on this interview, it is obvious that Dr. Mercurio has a large need for the telemedicine project. For the physician, telemedicine extends their ability to care for people beyond their normal reach. For the patient, it offers them the specialty care they need and will not fall into neglect. Dr. Mercurio's successful use of the telemedicine application has a big impact on the medical community at Strong Memorial. Barring the initial cost for implementation, it is a good example of how medicine can leverage information technology,

TELEMEDICINE FUTURE/DIRECTION AT THE UNIVERSITY OF ROCHESTER STRONG MEMORIAL HOSPITAL

The future of telemedicine at Strong Memorial Hospital looks very optimistic especially after the local area network went through a most awaited overhaul. Two and half years ago, Strong Memorial Hospital invested over $2 Million dollars to upgrade its existing Legacy backbone to one of the most advanced Fiber optic backbone within the University of Rochester and called it the Enterprise Network. The physical layer of the Legacy backbone comprises of many thick coax cabling that terminates to a singular router. There were approximately 28 subnets within the hospital network that made it very difficult to find a convergence point for a telemedicine application. The enterprise network's physical layer is all fiber optic and uses Asynchronous Transport system (ATM) as its main transmission system.

The URMC Telemedicine team was able to leverage this new technology for the implementation of the NYSDOC project. We had to run new cables for the conference rooms that are not properly wired to the legacy network.

Today, the NYSDOC project is closely linked to the ATM core backbone and had a major impact on the state of the telemedicine network, as shown on this diagram of the new Strong Health Videoconference Telemedicine Network (Appendix C).

Aside from the network overhaul, the Telemedicine group at Strong Memorial Hospital had gotten the recognition that it deserves. It now has complete administrative support staff and a stable funding. Several departments at the hospital are also leveraging the telemedicine network. Appendix C presents the new telemedicine infrastructure at Strong Memorial Hospital.

The Ascend Multiband is connected via a PRI to the new Madge Model 60 call gateway. This gateway is capable of receiving up to 52 calls. The Madge gateway is connected to another H.320/H.323 gateway to the URMC local area network. The Madge is also connected to the PSTN cloud via a PRI which connects to ISDN leased lines to six offsite location.

There are other telemedicine initiatives within the hospital. The Department of Pediatrics submitted four telemedicine proposal in November of 1997. ED had one proposal for a telemedicine application. The Department of Dermatology and Poison Control has been approved. The Department of Radiology has implemented a clinical archiving system at the hospital that makes the x-rays available for remote viewing. There are several video conferencing applications using the current telemedicine infrastructure. As of the writing of this paper, there is no accurate data on what telemedicine application has been approved. Appendix B is a short list of the Request for Proposals that was sent out in November of 1997. Several of these proposals are now running at Strong Memorial Hospital.

Telemedicine and the Health Insurance Portability and Accountability Act of 1996 (HIPAA)

Information technology has a definite role in today's healthcare industry and offers many potential benefits. With the availability of electronic medical records, hospitals can now offer a way of providing cost-effective access to more complete and accurate health data with which providers can make better decisions about patient care.[15] The sharing of patient information is intensified by the presence of advanced communications networks that enables sharing of data across distributed clinical systems.

Patient privacy has increasingly become more complicated especially with the presence of advance information technology. Use of information could be acceptable for some instances but can be considered invasion of privacy for others. Different areas of information privacy raise very different concerns and priorities. They also require different types of expertise to address them in a meaningful manner. The agencies currently involved with privacy issues, such as the National Coalition for Patient Rights and the National Information Infrastructure (NII), are dealing with specific areas of privacy that these agencies are uniquely qualified to handle (*e.g.* privacy issues arising in consumer transactions, in telecommunications, in law enforcement, in government records, etc.). [16]

In the United States, business and government have adopted sector-specific privacy rules, combining legislation, regulation, and voluntary codes to achieve the desired level of privacy protection in each sector. Each of these set of rules offers a different level of protection, and provides a different remedy. There already exist privacy laws that apply to patients in general. Such laws includes:

- The right of patients to determine what information in their medical records is shared with other providers or other institutions and agencies
- The right of the patient to know any disclosure of medical records outside the context of clinical care and should require the consent of the patient
- Or, the patient's legal right to review and copy their medical records.

The healthcare industry as a whole is facing financial pressures to reduce expenses and increase efficiency. The Hospital Insurance Portability and Accountability Act of 1996 (**HIPAA**) is hard at work to address these issues. Through government regulations, HIPAA promotes the greater use of electronic transactions and the elimination of inefficient paper forms. The regulations are expected to provide a net savings to the health care industry of $29.9 billion over 10 years, according to government calculations.

HIPAA is a comprehensive law that will drive the development of electronic data interchange (**EDI**) for specified administrative and financial healthcare transactions. Most of the healthcare institutions are now capitalizing on Internet technologies to deliver patient-related services and they must now comply with HIPAA regulations.

One objective of HIPAA (defined under Administrative Simplification) is the requirement for Congress to legislate a Patient Privacy Bill that will define rules for the protection of Patient Information. These rules will be applied through the security standards, policies, and practices that all entities must implement if they are to use, store, maintain, or transmit patient health information. Specifically, healthcare providers, payers, clearinghouses, billing agents, third-party administrators, will soon be affected by the requirements of administrative simplification and patient privacy. Again, this will affect any telemedicine applications because it's underlying objective is to provide medical services using remote access.

SUMMARY

Medicine at a distance is one of the most basic definitions of telemedicine. The practice may rely on satellite or ordinary telephone lines or it may involve television or facsimile.[1] Whatever the level of technological advancement, the same goal exist – to improve access to medical expertise. Throughout the world, Dr. Ken Bird and Dr. Max House inspired health care professionals closer to each other. It is by implementing a telemedicine and/or video conferencing technology that the hospital institutions can create a system by which they can service the needs of the local, regional, national, and even international communities. It readily provides an effective means for visual communication and collaboration and supports many of the healthcare institutions core activities. Telemedicine services also provides a good opportunity to engage in consultation and education in places beyond the traditional health care market, i.e. accessing new patient populations, sites for new research, and new venues for the exchange of educational programs. It can provide "second opinion consultation" wherein third world countries can consult with a more medically advanced like the United States.

To actually understand the passion and devotion of these physicians to the cause of telemedicine, I had to really read up on the many benefits it had provided. The applications it offers if unbelievable and definitely futuristic. According to the Association of Telehealth Service Providers in Portland, Oregon, the number of telemedicine consults has grown by 24% just in 1998 alone. In 1998, there were 52,000 telemedicine consultations, both physician-to-patient and physician-to-physician interactions. This is up by 10,000 from 1997. The 1999 figures are expected to be 74,000, which is an increase of 42% from year 1998. [17]

The most active clinical areas for telemedicine applications are dermatology, cardiology, orthopedics, neurology, and mental health. In the United alone, there are about 170 telemedicine initiatives.

The project itself offered me a hands-on experience on implementing technology but my research work has offered the most benefit. Considering that it was a relatively small project compared to other enterprise network implementation, it still had a major impact on the people's lives it touches, especially mine. We always say that technology changes everyday. This project gave me a chance to experience how it changes people's lives. It may not change my life at this very moment but I am sure that somehow telemedicine will soon touch my life and my children's lives. I am convinced that telemedicine is changing the dynamics of how health care is moving.

APPENDIX A

Telemedicine/Video Conferencing Budget Proposal

	NYSDOC/URMC	URMC
EMERGENCY DEPARTMENT		
Capital Costs		
Base System Concorde 4500, I-Mux, Installation & first year warranty	$40,980.00	$47,950.00
Remote Port Module	$2,412.00	$2,850.00
ATR Receive Ausculette Stethoscope	(DOC provided)	(DOC provided)
30 Frames/sec.	$6,201.00	$6,680.00
TOTAL	**$49,593.00**	**$60,380.00**
VIDEO CONFERENCING		
Capital Costs		
Base System Concorde 4500, Installation & first year warranty	$33,496.00	$39,190.00
Remote Port Module	$2,412.00	$2,850.00
30 Frames/second	$6,201.00	$6,680.00
ELMO Document Camera	$5,114.00	$5,700.00
TOTAL	**$47,223.00**	**$54,420.00**
INSTALLATION COSTS		
MCI T1 Circuit	No Charge	No Charge
T1 Extension to Med Center Media Center Studio	$150.00	$150.00
Cat 5 Lines from Media Studio to ED & Conference Rms	$2,790.00	$2,790.00
TOTAL	**$2,940.00**	**$2,940.00**
RECURRING COSTS		
T1, Access Loop (from Annex to MCI office electronics	$416.20/mo.	$416.20/mo.
Circuit Maintenance	$3.84/mo.	$3.84/mo
TOTAL	**$419.96/mo.**	**$419.96/mo.**
MISC. EXPENSES		
Renovation of ED Medicine Room	$3,534.53	$3,534.53
Telephone Installation	$150.00	$150.00
Training Costs for 2 Media Personnel	$3,600.00	$3,600.00
TOTAL	**$7,284.53**	**$7,284.53**
PER CALL COSTS		
Instate (standard call 6 channels)	$ .57/min/channel	$ .57/min/channel
Out of State calls	$ .06/min	$ .06/min.
Bridging Services (3 parties or more)	$ .98/site/min	$ .98/site/min
Gateway Services (needed if parties are not on the same MCI Dialing plan	$1.00/min	$1.00/min

APPENDIX B

Summation of Proposed Telemedicine Projects

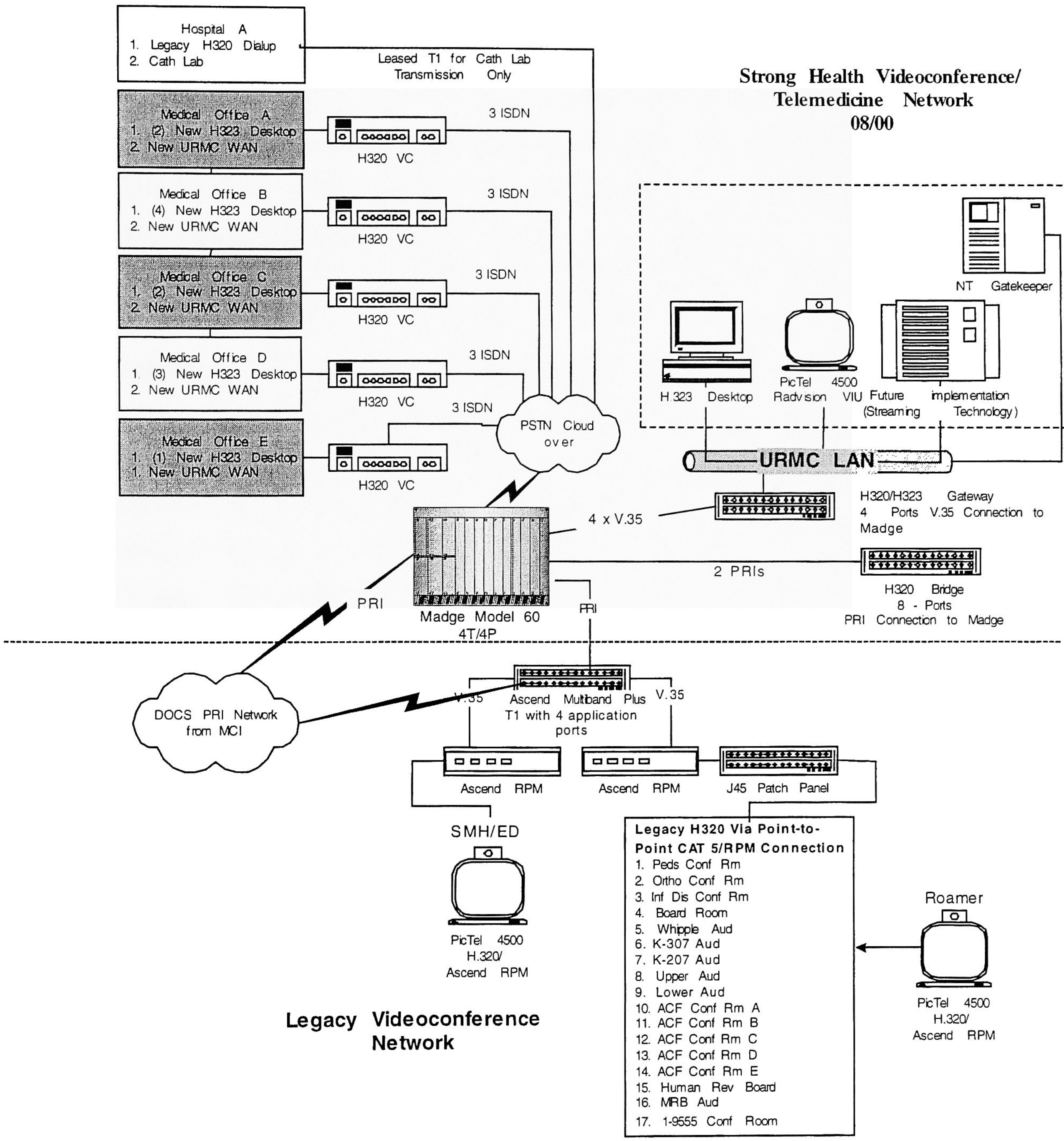
This list is just a partial list of the Request for Proposals (RFPs) done in December of 1997. Most all of the medical department at Strong Memorial Hospital submitted their proposals which included, project description and rationale, desired outcomes, support for institutional goals, participants, support services needed, source of external funding and the expected costs. As of the writing of this paper, there is no available source for the overall outcome of this request for proposals.

Department/Purpose	Description
Dept. of Physical Medicine and Rehabilitation – for Spinal Cord Injury (SCI) patients	Computer-based video teleconferencing can provide a vital link between the SCI program at Strong Memorial Hospital and the patient, either in their home or in a satellite facility. The paln involves the use of a portable teleconferencing system that would interface with the spine team over the Internet. Initially, the equipment would be kept at SMH and transported to the patients home as needed, or to a satellite facility for quarterly SCI outreach clinics. The SCI nurse liaison would be instructed in the use of the equipment and would transport and operate it.
Remote interpretation of X-Rays to expand Strong Health's Out-Reach Program	The main project goal is to increase the physician referral base and provide timely and cost effective radiological services to both patients and physicians in sites within the Strong Health service area.
Early Detection and Management of Mental Health Problems in Primary Care Settings: A Telemedicine Application for Depression	This proposal describes the opportunity to develop and deliver a first step in a disease management approach for depression, integrating mental health services with primary care. The primary care physician typically sees most mental health problems. Integrating accessible, rapid mental health services within primary care services can lead to more effective office-based treatment for mental health problems.
Department of Pediatrics Continuing Medical Education Program via Telemedicine	The Continuing Medical Education Program of the Department of Pediatrics holds a meets every month for informal discussions that counts towards CME credits. There are about 35 – 50 pediatricians and family medicine practitioners and attracts participants from the entire 15 county region in Western New York. The CME videoconferencing will allow for an expanded audience and more efficient use of time for actively participating physicians since there would be no need for prolonged travel to Rochester, especially in the wintertime.

Department/Purpose	Description
Department of Radiology	The department would like to leverage the existing telemedicine network to support off-site locations in providing clinical consultation. It will become more feasible for a radiologist to cover an off site location and as an expert system will obviate the requirement of an on-site radiologist to answer the majority of routinely asked questions concerning the imaging evaluation of patients.
OB/GYN Psychiatry	The OB/YN Department of Psychiatry would like to use the telemedicine network to provide remote diagnosis to women of childbearing age who would potentially be suffering from depressions. Psychiatric problems commonly develop in women of childbearing age. These reproductive years are the time of greatest risk for the development of depression and the lifetime prevalence of depression in females to males is 2:1. The goal to have early detection of depression.
Comprehensive Epilepsy Program (CEP) and the Neurophysiology Division	The CEP of Strong Memorial Hospital is a regional referral center for the diagnosis and management of intractable seizure disorders. The Neurology Division at SMH provides interpretation and consultation services for inpatient, outpatient, and intra-operative electroencephalograph (EEG) and evoked potential Epilepsy Program studies. The in future the division hopes to provide studies to a number of external sites through a wide area network. There is a desire to expand the EEG and EP interpretation and consultation markets, such as the VA hospitals.

APPENDIX C

University of Rochester Strong Memorial Hospital
Newly Upgraded Video Conferencing Network



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