National Laboratory for the Study of Rural Telemedicine
The University of Iowa
National Library of Medicine - Contract N01-LM-6-3548
March 31, 2000

ABSTRACT

On October 1, 1996 the National Laboratory for the Study of Rural Telemedicine began work supported by the National Library of Medicine (Contract N01-LM-6-3548) that continued until March 31, 2000. The purpose of the project was to evaluate the effectiveness of five separate telemedicine applications in a rural setting. This work was done in a rural test-bed network in eastern Iowa and was supported administratively by a Telemedicine Resource Center at the University of Iowa. The projects are described in detail in a Final Report and an Executive Summary. They are summarized below in brief:

Pediatric Echocardiographic Network: Pediatric Cardiology is a service that depends heavily on echocardiographic support. In a rural state, few sites exist to have this study performed. This project established telemedicine sites for this service. Over the course of the project 633 echocardiograms were transmitted from these sites. Diagnostic quality was excellent and the speed of diagnosis was enhanced.

Emergency Department Support for Vascular Ischemia: Myocardial infarction and stroke are major causes of death and disability in the rural setting. While new therapies are available and effective (thrombolytic drugs), they are difficult to administer in a timely fashion due to delays in diagnosis. This project developed a protocol-driven, computer- based wide area network for transfer of neurologic examinations, radiologic images, and other clinical data. Despite successful technical development and broad community participation, the application saw no significant use due to a number of factors, including Emergency Department (ED) staff issues (fragmented staffing patterns and significant staff turnover); perceived inadequate incentives to learn a new system; and entrenched reliance on more familiar (although less informative) means of communication.

Telepsychiatry Consultation: Mental health services are not readily available in the rural setting, and visiting consultants must travel long distances to provide care in a community setting. This project compared face-to-face consultation in a satellite clinic to consultation provided by telemedicine using a crossover design between two rural communities. There were no significant differences between face to face and telemedicine visits using a number of clinical, patient satisfaction and provider satisfaction measures.

Home Delivery of Diabetes Education: Control of blood glucose is a key factor in controlling diabetes complications. Education of newly diagnosed diabetic patients is key to long-term control. We developed an Internet-based education program and tested this approach in a randomized study using educational and physiologic end-points. The crossover has just occurred and will be completed in two months.

Consultation for Children with Disabilities: Caring for children who have severe developmental and emotional disabilities requires a comprehensive team approach. Travel to a tertiary site of care is difficult for children and their families. This project studied using videoconferencing for consultation in a case-controlled trial. There were no significant differences found between face to face and telemedicine services using a number of clinical and satisfaction variables. The overall appraisal favored telemedicine with a significant financial savings for the family in travel expenses, lost wages, food and lodging.

EXECUTIVE SUMMARY
By Michael G. Kienzle, M.D.

Introduction

Technology cannot be developed in a vacuum. In the case of telemedicine, its effectiveness is a reflection of the need addressed, the quality of the technology developed, the skill used in its deployment, and the attention paid to social and organizational factors involved in the work of health care. The larger health care environment also plays an important facilitating or inhibitory role through reimbursement policy, health system consolidation and integration, and changes brought about through marketplace reform. Given the complexity of the health care environment, it is not surprising that rigorous evaluation of technologies like telemedicine are difficult, and data supporting the effectiveness of telemedicine technologies have been limited.

In 1994, the National Laboratory for the Study of Rural Telemedicine was established at the University of Iowa with support from the National Library of Medicine (Contract N01-LM-4-3511). The purpose of the Laboratory was to determine health care delivery needs in the rural setting, develop technical approaches toward their solution, and test these applications in community settings. In the process, a unique test-bed network was established and available for the work of the current NLM contract (N01-LM-6-3548). A complete report of the initial work establishing the Laboratory and its programs can be reviewed at http://telemed.medicine.uiowa.edu.

The emphasis of the NLM project has been the evaluation of telemedicine as a means of providing health care services, with the emphasis on evaluation. The purpose of this report is to make available the results of our work during the contract period ending March 31, 2000.

PROJECT ADMINISTRATION – TELEMEDICINE RESOURCE CENTER

Problem Addressed

In many settings, particularly rural ones, multi-component, multi-site projects involving telemedicine or other technologies are not feasible without appropriate administrative coordination and support. Successful research and development projects consist of a large number of discrete and diverse activities, many of which do not fall directly into easily assignable categories. We have utilized an administrative structure initially patterned after the very successful SCOR, or NIH Specialized Center of Research, programs funded at the

University of Iowa. The TRC, like the SCOR administrative units, imposes a structure upon large and complex projects in several areas, including financial control, reporting, study design and analysis, regulatory compliance, information exchange and external relations. We believe the Telemedicine Resource Center has played a significant role in the success of both the individual projects and our overall program at Iowa.

Project Scope

The following summarizes the major responsibilities of the Telemedicine Resource Center at The University of Iowa:

- Administer, coordinate, and facilitate communication among telemedicine projects, telecommunications services, remote sites, and evaluation activities;
- Serve as the liaison to remote hospitals in our telemedicine network – provide end-user advocacy, training, and technical support to networked hospitals;
- Collect and manage utilization data for a variety of UI telemedicine programs and generate reports as requested;
- Provide teaching, training, internships, and practica opportunities for University of Iowa graduate students, medical students, and residents interested in learning about telemedicine;
- Host/train visitors to our telemedicine program from around the U.S. and from foreign countries
- Serve as an institutional resource on telemedicine to UI and outside entities;
- Administer all equipment requests, subcontracts, budgets, and consultant agreements for project directors;
- Use the telemedicine infrastructure and lessons learned to build out telemedicine services at The University of Iowa;
- Monitor state and national telehealth policy and contribute to legislation on telemedicine;
- Utilize NLM R & D projects to perform cost and viability studies for telemedicine;
- Disseminate information on UI's telemedicine program and NLM telemedicine activities via publications, presentations, the World Wide Web, newsletters, brochures, and other information dissemination mechanisms;
- Provide collection development services for telemedicine materials and make them available to users of Hardin Library for the Health Sciences;
- Contribute to the creation of a self-sustaining telemedicine program within the University of Iowa by evaluating cost recovery, reimbursement, and fee-for-service options.

Selected Accomplishments

The TRC staff used a variety of educational materials and sessions to help project directors and their staffs rapidly and efficiently plan and implement their work. This included helping with project budgets, procurement, travel, project planning and meeting management at UI and in involved communities. The TRC used a variety of communication strategies within the UI development group and with community hospital sites including secure email, a project intranet, a comprehensive WWW site, administrative videoconferencing, brochures and teaching materials, as well as site visits and on-campus meetings.

Managing a telecommunications project involving multiple facilities and covering a large region is daunting. Network performance was monitored and enhanced through a variety of strategies, including a mobile technical team, use of "black box" technologies for remote diagnosis and intervention, a telephone support line (800/606-4517) and end-user training.

The TRC staff played a major role in data management, particularly for those projects that did not have dedicated research personnel written into their projects. Specialized databases were developed (Telepsychiatry is an example) that could be modeled for use by other UI programs such as the department of corrections telemedicine project. The TRC played a major role in assisting project personnel with Institutional Review Board procedures and reporting.

The TRC also provided coordination and oversight for a number of educational programs and initiatives relating to telemedicine, including preceptorship experiences for Masters and PhD candidates, foreign faculty, NLM Associates, and a variety of other visitors to our institution. A particularly important activity was developing and teaching a course on telemedicine that has been incorporated into the curriculum of the UI Physician Assistant program. (A manuscript on this topic was submitted to *Academic Medicine in March, 2000*.)

The expertise of the TRC in budget oversight and cost assessment has been key to the smooth operation of a project of this size. This expertise has been applied to a number of settings, including an assessment of the factors impacting cost in a start-up telemedicine network for Iowa's prison population.

The activities and results of work done by the Laboratory have been very effectively disseminated through the efforts of the TRC staff. These include a quarterly newsletter, Health Connections, a comprehensive website (http://telemed.medicine.uiowa.edu), a variety of video productions illustrating the applications under development, presentation of results at numerous local, regional, national and international meetings and conferences, television and radio features and through written communications in magazines, journals and local and national newspapers.

Lessons Learned

Telemedicine development must start with an assessment of the problem that technology may or may not solve. It is unlikely that needs and problems will prove to be uniform across all rural hospitals and facilities. It should be remembered that technology implementation is inherently difficult in a remote and largely unsupported environment, so significant study and advance planning should occur as early as possible, well before significant resources have been allocated.

The health care and technology environments are both in a state of dynamic flux, and change must be anticipated and expected. The value of contingency planning cannot be overstated. To the extent possible, rapid prototyping and pilot testing should be employed and expectations of community-based collaborators should be informed by ongoing communication and education to minimize frustration and impatience that may occur when problems inevitably arise.

Human factors remain the most important determinant of success or failure of a specific application. Prominent among these factors include the 'politics' of patient referrals, fear of technology, impact on productivity of private and academic physicians, fragmentation of services at the local level, lack of local technical support, lack of reimbursement for most services, and differing opinions about health care priorities. These factors can be mitigated through advanced planning at the community level, a commitment to communication and training, and cultivation of key local liaisons and advocates.

Telemedicine has little chance for success as an independent activity. It must be integrated into an appropriate institutional environment and perceived as a useful tool to enhance existing relationships and delivery systems, not replace them. If an application cannot be incorporated into the mainstream of health care delivery within an institution or system it will never be sustainable, either due to lack of use or lack of support, or both. The appropriate question to ask is, "How will telemedicine improve the services we can already deliver, or improve a relationship we already enjoy?" While it is popular to think of these technologies as *revolutionary*, in fact they are (and should be) *evolutionary.*

Plans for Continuation

The TRC will continue as a service unit of University of Iowa Health Care, the clinical delivery enterprise of the University of Iowa Hospitals and Clinics and the UI College of Medicine. The TRC will join the Health Information Resources Group, concentrating on refining and further developing video services, including video development, videoconferencing and distance education. The TRC will continue to support R&D projects that have a telehealth emphasis.

PEDIATRIC ECHO NETWORK

Problem Addressed

Pediatric Cardiology is a medical specialty that provides care for infants and children born with congenital heart disease. Of all neonates born, eight to nine per thousand are afflicted with congenital heart disease and many present during early infancy as medical emergencies requiring surgical therapy. Other cases are not as emergent but require special skills of pediatric cardiologists to define the nature of the disorders so that therapy can be recommended to prevent life long debility or premature death.

In the past two decades, the technique of two-dimensional echocardiography has been developed. This technique allows the accurate diagnosis of most congenital cardiac defects when applied by pediatric cardiologists or technicians under the direction of pediatric cardiologists. In many centers throughout the State of Iowa, echocardiographic instruments have been purchased because of the need for echocardiography in adult patients, but in most centers no pediatric cardiologist is available to direct or interpret studies of children with suspected congenital heart disease.

Project Scope

Given these considerations, the objectives of this project, were:

- Establish on-line transmission of pediatric echocardiograms from several remote sites in Iowa.
- Train personnel at the remote site in echocardiographic techniques required to diagnose congenital heart disease in infants and children and indications for obtaining pediatric echocardiograms.
- Receive and interpret echocardiographic data from these sites.
- Evaluate the impact transmission and interpretation of echocardiographic images has on the care of infants and children in small and medium sized towns in Iowa.

Selected Accomplishments

The project has been able to establish echo transmission sites from a number of communities, including those identified in the proposal and several others. Moreover, several transmission modes have been evaluated, including very high-bandwidth (DS3), high-bandwidth (ISDN-PRI) and conventional courier services. Over the contract period, 633 echocardiographic studies have been received from these sites.

A successful program for the education of adult sonographers has been developed to support high quality pediatric echocardiography in remote sites. This program includes written and other didactic materials, hands-on training, and ongoing training in the context of transmission of studies.

The utilization and usefulness of echocardiographic transmission have been studied in a number of ways during the project. We have found significant differences in diagnostic yield that are dependent upon the specialty of the physician ordering the test and the age of the child. Additional studies have identified key variables in turn-around time and referring physician satisfaction with tele-echocardiography services.

This work has been reported at national meetings and in peer-reviewed journals. The program will be continued as a major supporting service of statewide pediatric cardiology outreach clinics.

Lessons Learned

The feasibility and utilization of pediatric tele-echocardiography services is highly dependent upon the mix of providers available in the community. Once expertise is available in the community, the demand for services will decline to levels that make sustaining such a program unlikely. Training and support of key technical personnel in the community will be essential to the successful delivery of high quality and clinically useful studies.

Cost-effectiveness is a relative term. When the costs of community-based echocardiographic services are considered, comparisons must be based upon the cost of providing comparable services at the community site using traditional methods, rather than the costs of providing the service at a different site (like the tertiary hospital clinic). In the case of pediatric cardiology diagnostic services, the community based outreach clinic costs are the most appropriate comparison. These tend to be infrequent, but costly services for the outreach cardiologists to provide. The cost of making a diagnosis by tele-echocardiographic transmission or through an outreach clinic is comparable, if not lower.

Plans for Continuation

The Pediatric Echocardiographic network will continue operations with existing rural sites, and anticipates adding new sites in the next year. Additional funding has been secured from the Children's Miracle Network ($100,000) to continue these interactions and to implement others. A telemedicine classroom in pediatric cardiology is under development that will allow other pediatric cardiologists around the state to interact with UI Pediatric Cardiology.

EMERGENCY DEPARTMENT (ED) SUPPORT FOR VASCULAR ISCHEMIA

Problem Addressed

Emergency services are key to successful treatment of a number of clinical problems, particularly in a rural setting. Acute ischemic stroke and myocardial infarction are clinical problems with a very strong time sensitivity given the compelling benefits associated with definitive treatment in the first 3-4 hours after symptom onset. Many rural emergency rooms are not equipped to make diagnostic and therapeutic decisions within this narrow window of opportunity because of lack of provider expertise and familiarity with the necessary protocols that must be followed to provide care that is more routinely available to patients in a non-rural setting. Telemedicine has the potential to provide such guidance and speed the decision making process so therapy can be started in advance of transfer or other disposition.

Project Scope

The aims of the project were to 1) develop the database and software for rapid diagnosis and consultation of acute myocardial infarction (AMI) and acute brain infarction (ABI) patients; 2) integrate the software with other data sources and teleconferencing software; 3) train physician users in use of the software and teleconferencing; 4) implement the system in 9 hospitals of varying sizes representing different capabilities and patient populations; 5) evaluate use of the system; 6) evaluate physician satisfaction at the local rural hospital and the tertiary hospital; and 7) evaluate patient outcome in terms of time to treatment, need for transfer, survival, functional outcome and cost of care.

Accomplishments

The project resulted in development of:

- A protocol using current clinical guidelines and practices,
- A means of dissemination of the guidelines and protocol through a conference, websites, local hospital presentations, and a comprehensive integrated database elements and algorithms,
- An integrated computer system for data transfer of neurologic exam, radiologic images, and clinical vital data,
- A system that utilizes scanners for paper documents and EKGs, still video cameras for imaging of radiologic films, and hand-held digital cameras for the neurological evaluation,
- An integrated pathway for consultation using a consultation network,
- A system of data transfer that provides information via the web which can make the consultation available through internet connections, and
- An assessment of videoconferencing and digital full motion imaging which still requires high-speed communication lines and computers with enough RAM dedicated to these process

Lessons Learned

It is possible to develop telemedicine approaches that arise from substantial need in a rural environment, are developed with full support and participation by community-based practitioners, demonstrate satisfactory diagnostic performance and facilitate guidelines-based practice, and still find the approaches underutilized in daily practice.

Complicating factors include fragmented systems of care for emergency services in the rural setting, a shifting level of clinical knowledge in the community, lack of perceived incentives for learning a new health delivery system, and entrenched reliance on more familiar (but less informative) means of communication.

Plans for Continuation

The University of Iowa has provided additional funding to extend telecommunications connections for an additional 3 months to allow more clinical experience, particularly in collaboration with a large Emergency Department (ED) group practicing at one of the test-bed sites. The application may also be modified to support specialty consultation within the UI Health Care environment itself.

TELEPSYCHIATRY CONSULTATION

Problem Addressed

In most rural settings the availability of mental health services is far outstripped by the demand for such services. This is particularly true for rural elderly patients, a population in which depression and other disorders are prevalent. While services can be provided in visiting consultant (satellite) clinics, serious limitations exist with this model for both patient and provider. Telemedicine has the potential to improve access to services if acceptable to patients and providers, if quality can be maintained and costs are comparable, or at least acceptable.

Project Scope

Prior to initiation of this study, the study investigator (Dr. Rohland) had been providing services to each of the two proposed study sites though the University of Iowa Clinical Outreach Program. In the first year of the study, careful planning was directed at developing procedures such as triage, on-site assistance, and outcome measurement at each of the two proposed telemedicine study sites. In years two and three, Telepsychiatry services were delivered to one new rural site per study year. In each of years two and three, the other rural site served as a no-telemedicine treatment control group and patients at those sites received traditional face-to-face services through the pre-existing clinical outreach program. After one year as a Telepsychiatry demonstration site, the experimental site was converted to no-telemedicine treatment control, and the no-telemedicine treatment control was converted to a Telepsychiatry demonstration site in a crossover design.

Accomplishments

A cross-over design was successfully used with the two study clinics. Total clinical experience was relatively low, but the quality of data collection was excellent.

Face-to-face and Telepsychiatry care was rated equivalent by patients judged on an array of dimensions, and Telepsychiatry was judged preferable by patients by in several others.

Clinical status and outcomes at the end of the cross-over period were judged to be comparable between the two methods of delivery.

Lessons Learned

No significant, pervasive, or consistent technical problems were experienced during the course of the study. Having the assurance of consistent, reliable, and immediate access to technical expertise and support (provided through the Telemedicine Resource Center) was essential to the success of this project. Such support will be important in order to recruit and retain both physicians and patients to the use of this technology.

Financial barriers present the greatest obstacle to the widespread implementation of Telepsychiatry in rural areas. It is doubtful that local sites would have supported the costs of equipment and transmission had it not been provided through grant support. Furthermore, third party reimbursement would not have covered nurse or physician services that were provided under the auspices of this project. Because our telemedicine nurse traveled to both the face to face and the telemedicine sites, costs of transportation were incurred at both sites. For an ongoing program, contracting with a local provider for on-site clinical coordination and support would have eliminated the cost of transportation to the telemedicine site.

Most rural delivery systems are fragile. Telemedicine should be considered as an ancillary rather than a primary service; it should seek to supplement or support local resources rather than to replace, substitute or compete with them. If the introduction of Telepsychiatry by an outside provider erodes the financial base of local providers, local resources will be difficult to maintain and the community will become dependent on a distant service provider who may not be committed to the overall well being of the local community. Local providers (and patients) may be reluctant to embrace Telepsychiatry (or other telemedicine services) if they are uncertain of the commitment and endurance of the providing agency. Furthermore, telemedicine is unlikely to be supported by local care providers (including referring entities) if they perceive it as being competitive to existing local resources, particularly services that they themselves provide. In the preliminary planning stages, local providers at potential telemedicine sites expressed willingness to refer only patients that represented a financial loss to the local provider (no third party coverage, or to groups of patients that were covered under a capitated contract that was deemed inadequate by local providers such as prison consultation and forensic court ordered evaluations).

An on site clinician (e.g., a nurse) is essential to the quality of Telepsychiatry. Although it raises concerns regarding confidentiality, it is essential for a clinical staff person to be present with the patient during the telecommunication. They must be able to trouble shoot technical problems (such as turning up the sound or refocusing the camera) as well as being prepared to address psychiatric emergencies such as threats of suicide or violence. At one of our sites, a patient expressed the intent to blow up a local electric company vehicle during the course of the evaluation. Appropriate (and immediate) follow-up would have been difficult had an on-site nurse not been present during this communication. The cost of an on-site provider, in addition to the telemedicine provider, is not likely to be reimbursed. Hence, telemedicine should not be promoted as cost saving. If done with an acceptable standard of clinical quality, it may be more expensive than traditional services. The primary advantage of telemedicine is that it provides a means to increase access to necessary or desirable services by patients who would otherwise not receive services or be underserved. Telepsychiatry should be viewed as an ancillary as opposed to a primary mechanism of service delivery in the provision of psychiatric services to persons who live in rural areas.

Administrative costs of scheduling and record documentation appear to be comparable to face-to-face assessment. However, it is important for measures to assure confidentially in the transfer and receipt of medical information via video transmission to be in place.

Telemedicine is an acceptable alternative to traditional face to face services by physicians, patients, and family members when it offers an advantage of convenience and/or cost over available alternatives. When patients have an established relationship with a treating psychiatrist, they appear to be willing to receive continuing services via telemedicine and appear to be able to do so without adverse consequences.

Plans for Continuation

Dr. Rohland has secured additional funding to continue telemedicine research in Texas. Dr. Flaum is working with state agencies such as the Department of Corrections and Iowa Medicaid to study use of telemedicine in these specific patient populations.

DIABETES EDUCATION

Problem Addressed

A number of studies and experiences have shown that education plays a major role in the outcome of patients with chronic illness. Recently reported data from diabetes intervention trials have demonstrated improved functional status with fewer complications when patients can more tightly regulate their blood glucose levels over time. At the same time, access to education about chronic illness is highly variable, particularly in remote settings, where specialized practitioners are unlikely to practice. Additionally, fewer health care resources are available for individualized patient education because of the declining financial performance of many hospitals and health systems. Alternative approaches are needed for patients with chronic illness, perhaps through the application of new and emerging technologies.

Project Scope

The objectives outlined in the proposal focused on computer-assisted instruction (CAI) and its potential as a cost effective way to help diabetes patients in rural Iowa better understand and subsequently manage their disease.

Two approaches have been pursued. The first involved developing systems to support in-home education through devices connected to the Internet, particularly the WWW. The second involved using targeted on-demand video to supplement instruction that occurs in the hospital and clinic setting.

Accomplishments

A WWW-based diabetes community application has been developed and refined. This application includes a specialized database of information, a community forum, and a messaging system. The system is under study using a control group with cross-over design.

A detailed study of user preferences was performed by directly comparing two different WWW access platforms, the WebTV and the Apple iMac. While both appear to provide reasonable basic support for some functions, many characteristics important to the educational experience strongly favor the all-in-one iMac computer platform.

A working prototype of an enterprise-wide video file-server has been developed and populated with a variety of diabetes related materials in support of the project. This application, dubbed the UI Health Care/NLM Cineplex is in the early phase of patient testing. In its current configuration it will determine basic demographic information about the user, present a catalogue of relevant materials, display TV quality video and permit post-viewing queries to the user. The system will allow up to 100 simultaneous user to access the system.

Lessons Learned

The types and amount of information available to patients and health care consumers has exploded since the beginning of this contract. A patient with diabetes in Iowa using the Internet is able to access information from all over the world. However, in order for this access to care to be optimally used and appropriately incorporated into local care, the information system should be part of a larger information "community" in which communication with care providers and other patients is an intrinsic part of the system.

The current technology environment is a difficult one for those who seek to improve access to information for patient communities. Changes in platform, software systems, telecommunications options and even basic programming language all impact on the route that development of systems may take. This occurs even when "off-the-shelf" solutions are favored and utilized. The net effect is one of frequent re-direction of effort, re-engineering of approach, and exhaustion of human resources and project momentum.

Once systems are developed and ready for deployment, a great deal of effort is needed to assure that proper training and ongoing support have been allocated, designed and made available to patients and their families. This is particularly true for those who by virtue of age, experience or financial status are unfamiliar with advanced technology. The incremental effort needed to connect the unconnected among us in the future will be considerable. Hopefully, with the passage of time the expectation of access to information resources will replace technophobia and re-establish a new baseline of user requirements.

Plans for Continuation

The University of Iowa has provided funding for additional telecommunications services to complete the cross-over study. Once validated, the Living with Diabetes format will be used to develop Internet communities for a number of chronic disease patient populations, such as cancer, asthma and others. The Cineplex application is being rolled out in the next month for patients and UI Health Care staff.

HOSPITAL SCHOOL

Problem Addressed

Among the estimated 50,000 to 70,000 children in the state of Iowa who have disabilities, there is a host of primary diagnoses including neuromuscular disorders, myelomeningocele, Down syndrome, mental retardation and other types of chronic health concerns. For those with more severe disabilities, these primary diagnoses are frequently compounded by secondary disorders, including chronic health problems resulting from the etiologies of the primary disorder and/or associated problems such as self-injury. Despite the high quality primary care and services to children with disabilities in Iowa, a significant number of these children exhibit complex anatomical, physiological, and/or behavior problems that require expert interdisciplinary evaluations and care planning that frequently are unavailable in their local communities.

The project was developed to test the potential of the Iowa Communications Network (ICN), a statewide fiber optic system, to assist the UHS to provide these selected tertiary level services in a manner that is optimally efficient for parents of the patients, community care and service providers, and UHS staff. An ICN studio was constructed at UHS and became operational in March, 1996. The studio is designed to provide optimum flexibility for live, fully interactive clinical service delivery.

Project Scope

This project was designed to evaluate selected clinical services that are now provided on site in UHS that can be provided by this telemedicine approach. The primary questions of this project focus on:

What types of selected clinical services or components that are now provided on site at UHS can be offered over the ICN effectively?
What is the satisfaction and reported effectiveness of providing telemedicine consultations to children/families and providers in a rural state in the view of families and their providers?

Accomplishments

During the performance of this project, the investigators have:

- Designed and tested the necessary procedures, protocols and processes to effectively deliver consultation through telemedicine to defined populations of children with disabilities.

- Evaluated the effectiveness of telemedicine consultation using a rigorous case-control design.

- Demonstrated that telemedicine consultation was at least as effective as face-to-face consultation from the perspective of patients, parents and providers.

- Demonstrated a substantial economic benefit to families and the agencies that support them by reducing costs related to travel expense and lost productivity.

Lessons Learned

The following factors are key lessons learned and the major issues in enhancing the success of telemedicine in this project for children and families in rural Iowa:

- Collaborative and mutual development of clinical evaluation protocols is essential to success.
- Local coordinator of scheduling familiar with local professionals and agencies is necessary.
- Specific agenda for the telemedicine consultation prepared in advance insures quality.

- Discussion of recommendations for treatments during the telemedicine consultation fosters 'best practices'.
- Demonstration of evaluation/treatment procedures by professionals at both sites promotes learning.
- Timely scheduling of requested consultations and evaluations is a key to successful local acceptance.
- Quality and reliability of technical infrastructure of video connections is needed.
- Adequacy and timeliness of written clinical reports following telemedicine consultations insures acceptance.
- Prior training of local community-based professionals with telemedicine procedures is imperative.
- Confidentiality of studio locations is central and must be maintained.
- Pre-determined agenda for telemedicine sessions with designated manager at respective sites promotes a smooth clinical experience for all.
- Preliminary introductions of all telemedicine participants – social etiquette is important.

Plans for Continuation

The following will occur as a result of the contract work:

Incorporation of telemedicine consultation and evaluation model as part of the regular clinical service venue.

Hosting a meeting (October 1999) with all 15 directors of Special Educational Services (service system for special education for the entire state of Iowa providing services for all of Iowa's school-age children and youth with disabilities – all types) and development of a statewide partnering of telemedicine services.

Consultation with the Child Health Specialty Clinics (CHSC), the state Title V program for children with special health care needs. We anticipate the collaborative development of new telemedicine consultations in concert with this state/federal agency. Plans are currently in process for new telemedicine sites and services: Feeding Disorders in Children with Special Needs, Down Syndrome Clinic, Children with Specialized Nutritional Needs, Postural/Support Service (special mobility, seating consultation), Specialized Consultation for Severe Behavioral Disorder (Des Moines Public School System in central Iowa) and Children with Pain (Juvenile Rheumatoid Arthritis).

Continue to offer consultation services with the four care teams.

PATIENT CONFIDENTIALITY, SECURITY AND INFORMED CONSENT

The projects were carried out using a variety of computing and telecommunications approaches, including video (Disabled children consultation, Psychiatry consultation, echocardiographic transmission), WAN (Emergency Department support), and Internet (ED support, Diabetes education).

For video related projects, two approaches were taken. First, point-to-point ISDN has the same circuit security as a telephone call, with the added security of being a digitally encoded signal, requiring a decoder for use. For switched DS3 service on the Iowa Communications Network, transmissions were "blacked out" electronically and not viewable by telecommunications personnel.

For WAN applications used in the Emergency Department Support project, security and confidentiality was maintained using Windows NT challenge/response logon validation, digital certificates, and secure socket layer Internet protocols.

For the Diabetes Education project, in which security and confidentiality were of lesser concern (given the nature of the project), the experimental website was an unpublished URL and only patients participating as study subjects were registered to use its functions. If the system did not recognize the user's profile and IP address, access to the site would be denied. The site was moderated and monitored by study personnel.

Patient confidentiality was assured using existing policies and procedures in force within each hospital as related to privacy, medical record security and access to records. Each actively participating patient provided informed consent and each project was reviewed by the IRB at the University of Iowa.

CONCLUSIONS

Based on our collective experience gained during the current NLM contract, we offer the following brief and general conclusions:

Considerable economic benefit is provided to patients and their families by the improved access to specialty services and avoidance of costs associated with travel. When considered in the context of the clinical effectiveness of telehealth services, the case for telemedicine is even more compelling from the patient perspective.

For *providers* of specialty health care services, the value of the proposition is less clear, and may vary considerably from one clinical application to the next. Given the lack of routine reimbursement for telehealth services and the fact that the most significantly demonstrable economic value goes to patients and families, benefits for telemedicine service providers in the current environment are less obvious and must be viewed from a broader health system perspective. This perspective must take into account the favorable impact telemedicine programs may have on referral and other relationships. The extent to which telemedicine is viewed as one of several tools for clinical relationship-building and patient care will determine whether decision-makers continue to support telemedicine programs when external funds terminate or are otherwise unavailable. Given the results of our current and past projects (and others), we believe that telemedicine is "safe and effective" and should be made available to patients and reimbursed on the same basis as traditional health care services. While the federal government has taken a few halting steps in endorsing this position, much more leadership is needed to put telemedicine on an appropriate footing in the health care system.

The implementation of telemedicine may prove to be difficult. The least of these difficulties is technology. Education, support, motivation, and training of providers are critical. The need to recognize and mitigate political and social factors that stand in the way of success are often ignored, at considerable peril. The incentives needed for full participation and evaluation of telemedicine are not yet present, particularly in the area of payment for service. We find ourselves in a "no job without experience and no experience without a job" situation. The somewhat slow and cumbersome efforts toward the documentation of telemedicine outcomes has created the (we believe) false impression that telemedicine doesn't work. Under the leadership of the NLM, and with assistance from entities such as the Institute of Medicine, a more accurate picture of telemedicine is emerging.

FINAL REPORTS FOR NATIONAL LIBRARY OF MEDICINE CONTRACT N01-LM-6-3548

TELEMEDICINE RESOURCE CENTER, SUSAN ZOLLO, M.A., DIRECTOR.

Introduction

Telemedicine is a diverse, multi-disciplinary activity that benefits from the input of primary care providers, consultants, patients and families, researchers, policy makers, telecommunications specialists, and many other individuals and groups. Small, rural, and underserved hospitals, although enthusiastic about the potential of telemedicine, are often overwhelmed by the number of people, processes, and technological installations required to build a high speed telecommunications network for the exchange of complex data and video applications. Academic health centers, often the hub of such networks, have become more and more specialized, departmentalized, and fragmented causing additional challenges to the implementation of fully integrated, collaborative, and need-driven networks. Finally, the larger telehealth environment has introduced overarching challenges such as limited reimbursement, complex telecommunications legislation, interstate licensure restrictions, liability and patient confidentiality issues, and competitive hospital alliance building to this already volatile mix. A coordinating entity, such as the Telemedicine Resource Center developed at The University of Iowa, can work with both the academic hub hospital and rural telemedicine partners to ensure smooth communication, need-based services, technical support, end-user training and advocacy, evaluation of provider and patient satisfaction, and monitoring of the national telemedicine environment for both providers and patients involved in telemedicine. This report will outline the organization, development, goals and services of The University of Iowa's Telemedicine Resource Center.

Staffing and organization

The Principal Investigator of the Rural Telemedicine Lab is Michael G. Kienzle, M.D., Associate Dean for Clinical Affairs and Biomedical Communications, and Professor of Internal Medicine at The University of Iowa. Staffing of the Telemedicine Resource Center began in June of 1994 with the appointment of the Resource Center's Director. Staff positions were filled according to the level of effort requirements stipulated in our contract and in support of telemedicine development at The University of Iowa. Staff members include the Director, Project Assistant/Accountant, Evaluation/Outcomes Coordinator, Technical and Systems Manager, and Secretary.

The team approach to staffing the Telemedicine Resource Center has facilitated implementation of this large, multidisciplinary program at The University of Iowa. In addition to the specific deliverables outlined in our contract, the Resource Center team has been an information resource for many facets of telemedicine program development at this institution, including the Iowa Department of Corrections and home health telemedicine programs; health professionals training programs for new data and video technologies; establishment of the Resource Center as an information and referral center for telemedicine; integration of telemedicine into the health sciences curriculum; and participation in Iowa's telemedicine Medicaid reimbursement program.

Administration, Coordination, Communication

The following list summarizes the major responsibilities of the Telemedicine Resource Center at The University of Iowa:

- Administer, coordinate, and facilitate communication among telemedicine projects, telecommunications services, remote sites, and evaluation activities;
- Serve as the liaison to remote hospitals in our telemedicine network – provide end-user advocacy, training, and technical support to networked hospitals;
- Collect and manage utilization data for a variety of UI telemedicine programs and generate reports as requested;
- Provide teaching, training, internships, and practica opportunities for University of Iowa graduate students, medical students, and residents interested in learning about telemedicine;
- Host/train visitors to our telemedicine program from around the U.S. and from foreign countries;
- Serve as an institutional resource on telemedicine to UI and outside entities;
- Administer all equipment requests, subcontracts, budgets, and consultant agreements for project directors;
- Use the telemedicine infrastructure and lessons learned to build out telemedicine services at The University of Iowa;
- Utilize NLM R & D projects to perform cost and viability studies for telemedicine;
- Disseminate information on UI's telemedicine program and NLM telemedicine activities via publications, presentations, the Web, newsletters, brochures, and other information dissemination mechanisms;
- Monitor state & national telehealth policy and contribute to legislation on telemedicine;
- Provide collection development services for telemedicine materials and make them available to users of Hardin Library;
- Contribute to the creation of a self-sustaining telemedicine program within the University of Iowa by evaluating cost recovery, reimbursement, and fee-for-service options. (Attachment 1)

In order to facilitate communication among project directors, consultants, researchers, and clinicians, standing meetings instituted for the first telemedicine contract were continued for project investigators in our current contract. A monthly Executive Committee meeting was scheduled as were bi-monthly telecommunications meetings. Individual ad-hoc meetings between staff of the Resource Center and project directors were scheduled on an as-needed basis to ensure optimum communication regarding budgets, equipment purchases, outcomes planning, personnel, travel to remote hospitals, training, and computer support. A monthly calendar of NLM events, meetings and travel was distributed to all project participants and made available on our Intranet site. Documentation made available through the Resource Center includes contact information for rural hospital liaisons; location information and IP addresses of all remotely deployed computers, hubs, and routers; correspondence between hub and telemedicine hospitals;

records of phone contacts; travel summaries; and other information relevant to project participants.

In the first month of the project, TRC staff reviewed contract deliverables and formatted them into timeline grids. The timelines were distributed to the project directors for each clinical telemedicine service to ensure timely compliance with implementation of this project's overall goals and objectives. Notebooks were assembled for each project director outlining reporting requirements, UI procedures for requesting approval to conduct patient research, diagrams of our existing telecommunications infrastructure, and information about the National Library of Medicine.

The TRC prepared a briefing booklet that described our NLM telemedicine award, provided abstracts of our newly funded clinical telemedicine services, delineated our telecommunications infrastructure, and summarized our new contract deliverables. This booklet was distributed to our remote telemedicine sites as well as to local media and individuals and entities contacting our program for information about our telemedicine services and programs. (Attachment 2.)

A UI Motor Pool car was reserved to facilitate frequent travel to the remote hospitals for year 01. To avoid disruption to the remote hospitals, project directors were encouraged to combine travel plans whenever possible.

Finally, an evaluation summary was prepared based on the general guidelines established by the Institute of Medicine in their Report, Telemedicine: A Guide To Assessing Telecommunications in Health Care. (Please note: Any data collection activities and surveys that were performed by this project reflect University of Iowa Health Care Quality Assurance guidelines. No NLM funds were used to support any surveys or data collection activities that would violate the Office of Management and Budget's oversight of the Paperwork Reduction Act.)

Telecommunications network, computing, and troubleshooting support

(See also Telecommunications Section of this Report.) Under the terms of our first NLM contract, there were ten hospitals connected to the UI telemedicine network. Our second contract allowed us to build on the infrastructure that was already in place. The network for our current contract includes: Genesis Health Systems in Davenport, Ottumwa Regional Health Center, Van Buren County Hospital in Keosauqua, Burlington Medical Center, Grinnell Regional Medical Center, Henry County Health Center in Mt. Pleasant, Jefferson County Hospital in Fairfield, Keokuk Area Hospital, Muscatine General Hospital, and Washington County Hospital. Since the development of the original network, the Telemedicine Resource Center has developed a number of initiatives which have led to continued network expansion and growth. In addition to the hospitals listed above, we have now added to our network hospitals in Ft. Madison, Perry, Des Moines, and Manchester for a total of fifteen hospitals including the UIHC.

Iowa is fortunate to have the nation's first and only statewide fiberoptic infrastructure available for educational and health-related applications. With points of presence in all 99 of Iowa's counties and over 600 endpoints currently connected, the ICN remains a major leader in worldwide telecommunications. However, due to the expense of developing and sustaining a DS3 network connection to local hospitals, (sometimes referred to as the 'final mile' connections), the UI requested and received permission from the NLM to build a point-to-point T1 network to each of the hospitals from the Iowa Communications Network (ICN) hub in Des Moines. It has been estimated that, although we are not using fiberoptics for the final mile solution to connect remote hospitals, circuits purchased through the ICN have saved our project about 1/3 of the connectivity costs when compared to circuits provided by other telecommunications carriers. The T-1 bandwidth has proven to be more than adequate to provide high-speed, high-resolution connections from the UI labs where the projects were developed to designated sites in the remote hospitals. The network infrastructure developed for this program has been extremely reliable.

TRC staff identified requirements to provide optimal administrative and technical support services to their local and remote network colleagues. One of the most important tasks was to provide access to a secure server for electronic mail; file sharing for such distributable items as agendas, minutes, schedules, reports, etc.; a World Wide Web (WWW) site for the Resource Center and affiliates; and listserv capability for announcements and discussion forums. To that end, the TRC placed into production a Microsoft NT network server with the following hardware and software: Hewlett-Packard NetServer; LX Pro Dual-processor; Pentium Pro 2XP6/200; 128M RAM; 2X1G EIDE hard drives; 4X4G SCSI 'hot-swappable' hard drives; APC Smart UPS; and 2200 Microsoft NT Server Software, version 4.0. The Microsoft NT server was installed and mirrored on two 1-gigabyte EIDE hard disk drives. Three 4-gigabyte hard disk drives were configured using RAID 5, a format also known as disk striping with parity. This configuration yields 8-gigabytes of useable storage. One 4-gigabyte hard disk drive is held in reserve. The server was plugged into an APC UPS in order to provide a stable power source as well as capability for an orderly shutdown in the event of a power outage.

As an adjunct to the email server, The University of Iowa's Telemedicine Intranet site was created to further facilitate information sharing among the many projects and participants involved in our NLM contract. The Intranet site was developed as a low cost alternative to distributing and mailing paper correspondence and project news and updates. It also allowed the Telemedicine Resource Center to revise contact lists, calendars of events, and other items of general interest in a timely manner. The site was developed using a recycled Apple Macintosh Performa 6115CD. This computer was previously used by the Telemedicine Resource Center's Editorial Associate to develop the Health Connections newsletter and other telemedicine project printed materials. Additional memory was added to the computer and the shareware software Quid Pro Quo was downloaded and installed from the Internet. The HTML markup was done using Claris Home Page version 2.0. Adobe Photoshop was used to develop the graphical interface. To access the Intranet site type in the following Uniform Resource Locator (URL) http://128.255.81.29/insite/home.html.

Finally, in order to maintain optimal functionality for the workstations located in our telemedicine sites, we continued making available our toll-free line in the Telemedicine Resource Center for end-user technical support. (1/800/606-4517.) Support was available to the rural hospitals between 8 and 5, Monday through Friday - i.e. normal working hours. Timbuktu, which is software used to control distant workstations on a network (i.e. up to 90 miles away in one case), was installed on all computers in the remote hospitals. In so doing, we were able to minimize downtime and be very responsive to problems that end-users brought to our attention over the phone. Numerous software fixes that might otherwise have required a site visit requiring up to an entire day of travel were executed successfully in a matter of minutes using Timbuktu. Because of this strategy, end user satisfaction with workstation performance was enhanced.

Data Management

The TRC provided telemedicine data collection and data management services to projects that did not have a Research Assistant. The Research Coordinator in the Telemedicine Resource Center created a model for project data collection and management that is also being utilized in non-NLM projects as telemedicine service expands within the institution.

Telepsychiatry

Development of the Telepsychiatry database began by determining what patient information would be collected and for what purposes it might be analyzed and reported on in the future. UI clinical evaluation instruments for patient consultations were reviewed as were patient records that included demographic and appointment information. These data elements formed the basis of the variable field definitions for our telemedicine databases. The patient satisfaction data collection instruments used in this project were: Process of Care Logs (initial intake and following visit); CORM satisfaction survey (Clinical Outcomes and Resource Management); GAF (Global Assessment of Functioning) score; and the Mini Mental Status Exam (MMSE). These instruments are part of UI's existing quality control and patient satisfaction evaluation mechanisms and since no NLM funds were used for their development and distribution, they are not in violation of the OMB's Paperwork Reduction Act.

After defining and selecting appropriate fields from existing data capture instruments, tables were created in Microsoft Access and forms were designed to facilitate report generation. Two separate forms were created for the data in the Access database. The first form includes patient demographic data gathered from Informm. These data usually do not change from visit to visit. (Figure 1)

The second form includes clinical data from the visit. (Figure 2) All instruments used during the individual patient interaction can be recorded on the same Access form.

The screen capture in figure 3 displays patient data queries. The database administrator can choose a query, select the data, then copy and paste into an Excel spreadsheet for representation via graphs or charts. Patients' names are **not** included in this database. Hospital numbers **were** used so that demographic and consultation information could be obtained from the medical record. The database administrator was required to fill out a confidentialty statement prior to adding patient information to the database.

The Telepsychiatry database has been used in the preparation of several presentations, reports, abstracts, and articles for Dr. Rohland and other Telemedicine staff at The University of Iowa. The final data set for the project was forwarded to Dr. Rohland, now on the faculty of Texas Tech University.

Problems encountered in data collection for Telepsychiatry.

One of the administrative problems encountered during implementation of the Telepsychiatry project involved scheduling miscommunications between the Washington County Hospital (remote site) and the University of Iowa Clinical Outreach Department (hub hospital). Clinic patients who rescheduled or canceled appointments were contacting the Washington County Hospital scheduler and these changes were not being passed along to UIHC tele-psychiatry staff. This resulted in unanticipated no-shows or, conversely, patients showing up in their local hospital only to find that the UI psychiatrist was unavailable to provide telemedicine service from UIHC because no one had been notified of the 'add-on' appointment. After some investigation, it was discovered that WCH had experienced significant staff turnover among their schedulers, and new staff were not being properly trained in telemedicine protocols and procedures. Although this situation was remedied once the problems were identified, the crossover design was implemented soon after, and some of the same scheduling problems occurred in Keosauqua. The key to solving this problem, as is often the case with telemedicine, was improved communication and proactive problem-solving between the provider and recipient sites.

Additional challenges had to do with facility preparation for telemedicine at the remote sites. For example, in Washington a renovation project that included the telemedicine suite was delayed because of unanticipated structural problems beyond the control and scope of the telemedicine project. The lesson learned in all cases has been that Telemedicine planners may have to respond proactively to unanticipated obstacles at the remote sites over which they may exercise little or no control. Again, communication and documentation are key to handling these challenges when multiple entities, facilities, and staff members are involved.

Future data collection activities for telemedicine

The development of the Microsoft Access databases for the NLM Telepsychiatry project and the programmatic lessons learned along the way have allowed the Telemedicine Resource Center to better support new and expanding telemedicine services under development at University of Iowa. For example, much of the clinical data being collected by The University of Iowa at the present time is being generated by UI's telemedicine service to the state's correctional facilities. Figure 4 shows the database created by the TRC for capturing this clinical data.

The Microsoft Access database shown in Figure 4 is currently maintained for entry and analysis of demographic, clinical, and physician satisfaction data from the Prison Telemedicine Program. Data is entered from three sources: 1) the Informm system; 2) a patient encounter form; and 3) an annual physician satisfaction questionnaire collected from referring and consulting physicians. Demographic information, diagnosis codes, and follow-up actions are available for evaluation and comparison with both on-site and Outreach visits.

Data from TRC databases have been used to create several types of reports for UI Health Care. Attachment 3 provides an example.

Pediatric Genetics

Building on our NLM project-based Microsoft Access experience, a database was also developed for Kim Keppler, M.D. for her pediatric genetics counseling service. Dr. Keppler participated in an Iowa Medicaid Reimbursement project to collect clinical data that could be used to evaluate whether telemedicine is a viable and efficacious way to provide such service. Participation in the Medicaid Reimbursement project required consulting and referring physicians as well as patients and families to fill out several forms. Again, TRC staff were able to replicate the forms in an MS Access database for easy data capture and report generation for the Iowa Department of Health and Human Services, the entity that administers the Medicaid Pilot Telemedicine Program. Brief analyses of preliminary data were also used to prepare various presentations and abstracts for Dr. Keppler.

Institutional Review Board

Another advantage of having a Research Coordinator overseeing telemedicine R & D activities is that this person can advise physicians on the process of Institutional Review Board (IRB) procedures and approvals. Because telemedicine is somewhat outside the scope of more traditional IRB requests, the Research Coordinator has been able to serve as an advisor to faculty and staff from many departments and projects who are applying for telemedicine IRB approval within the institution. Rather than having each physician try to figure out a workable approach on their own, the Telemedicine Research Coordinator was able to provide a model or template for new investigators.

In summary, we believe that a centralized facility for telemedicine research can effectively assist the institution in 1) identifying and overcoming some of the administrative barriers to telemedicine 2) standardizing data collection and reporting procedures; and 3) utilizing lessons learned to assist new telemedicine programs to become fully functional.

Integration of Telemedicine into Health Sciences Curriculum

It has been suggested that one of the best ways to 'mainstream' telemedicine is to incorporate it into the health sciences curriculum. In this way, health professionals going out into the field will be able to teach practicing physicians and other clinicians about the potential benefits of telemedicine for primary care providers and their patients.

To date, individual classes on telemedicine have been taught to UI students in Medicine, Nursing, Biomedical Engineering, Health Informatics, Library and Information Science, and the Business College. In addition to classes, the Telemedicine Resource Center has been approached by several programs seeking practica for their students. Since the telemedicine program's inception in 1994, several UI students have completed practica at the Telemedicine Resource Center, taking advantage of faculty and staff expertise as well as the wide variety of telemedicine applications (both clinical and R&D) currently underway at the UI. Modules on telecommunications, administrative issues, clinical applications, on-line library services, and tele-education have been incorporated into these practica so far. The TRC has trained students working toward their Ph.D. in Nursing and students working toward graduate degrees in Educational Technologies and Library and Information Science. Practica have been customized so that students are not only earning credit hours, but come away with a practical knowledge of everything from how managed care and reimbursement impact telemedicine, to how to turn on the equipment.

UI's Physician Assistant Program, ranked fourth in the U.S. by News Online, Best Graduate Schools of 1998, was the first to formally incorporate telemedicine into their curriculum. (Figure 5) The classes (four 2-hour sessions) were taught in the beginning of the Spring semester, 1999 by the Director of the Telemedicine Resource Center and a number of faculty and staff involved in telemedicine or related activities. In addition to overviews of telemedicine, there were sessions on UI's Computer Based Patient Record project, (taught by James Flanagan, M.D.) and a session on ethical issues in Telemedicine (taught by Preventive Medicine Project Associate, Jeff VandeBerg, M.A.). The last session included a live telemedicine interaction between Van Buren County Hospital in Keosauqua, and UI faculty psychiatrist, Barbara Rohland, M.D., who began Telepsychiatry at UI with her NLM-funded project with Washington and Keosauqua, IA. A patient simulation exercise included use of a digital stethoscope which allowed the PA students to hear the heartbeat of a patient who was about 90 miles away.

Hosting Telemedicine Investigators from Other Institutions

"I believe telemedicine is, by definition, a global enterprise. We consider ourselves to be a national and international program." -- Michael G. Kienzle, M.D., 1996.

Since October of 1996 we have had seventeen international visitors from countries such as Japan, Taiwan, Russia, Israel, Wales, Venezuela, India and Germany. Some of our guests were part of well-established telemedicine programs and were interested in our projects participating in an informational exchange. Others wanted to begin their own telemedicine programs and were in an initial, information-gathering phase.

Our challenge was to prepare itineraries (Attachment 4) for our visitors fashioned around their expressed interests, giving them maximum amount of information in a minimum amount of time. Areas of interest ranged from general rural telemedicine to computer-based patient records to Telepsychiatry. By hosting a number of national and international visitors to our telemedicine program, we have tried to assist others who are just getting started in this field.

It continues to be our pleasure to host international telemedicine representatives participating in this truly "global enterprise."

Budget and Equipment Oversight

The accounts manager for the TRC provides oversight of investigator budgets by coordinating and overseeing all project budgets and accounting issues related to the contract. This includes obtaining Contracting Officer Authorizations (COAs) to expend funds not in the original proposal or request equipment purchases over $1,000; reconciling statements of accounts; tracking all expenditures and producing detailed monthly expense reports for investigators; overseeing monthly billings from the ICN and other telecommunication providers serving our remote hospitals; providing utilization information (cost per minute line charges) for project directors and staff; managing salary data and verifying level of effort; ensuring correct processing of requisitions for supplies and equipment orders; and troubleshooting problems for grant accounting and other UI departments.

Beyond the scope of the NLM projects, the value of having a telemedicine accounts manager is that this person can provide the institution with such services as: budget projections for investigators new to the telemedicine field; documentation of telemedicine cost data requested by UI administrators for annual reports and budget justifications; equipment and staff costs for developing future telemedicine projects and grant applications; and coordination of institutional telemedicine purchases to avoid duplication and gaps in infrastructure development.

Telemedicine Information Dissemination.

In addition to our Web site, presentations, press releases, and publications, the TRC uses a number of information delivery mechanisms to 'get out the word' on telemedicine.

Newsletter

"Health Connections" is a quarterly newsletter distributed to healthcare providers and educators at the University, state, national, and international levels. (Attachment 5) Staff from the TRC research, write, edit, design, and desktop-publish this newsletter. Articles focus on telemedicine projects funded by the NLM and other UI telemedicine projects that have developed, many of them as a result of the investment that the NLM made at this institution. Another information dissemination mechanism is our web site which offers electronic access to our newsletters, progress reports, and other information about our projects and other relevant publications and links. (http://telemed.medicine.uiowa.edu).

Cost Studies and Other Telemedicine Reports

In order to establish UI's Telemedicine Resource Center as a statewide resource for telemedicine activity, the TRC has produced a number of reports on telemedicine-related topics. Examples of such reports include: two annual reports for UI's clinical telemedicine services to the state's nine correctional facilities (Attachment 3 is the most current); the Iowa Telehealth Directory describing current telehealth activity around the state (Attachment 6); a Business Plan for Telemedicine (Attachment 1); and various PowerPoint presentations describing national and local telemedicine initiatives. (For examples of PowerPoint presentations, please view the home page on our web site http://telemed.medicine.uiowa.edu)

Telemedicine Information Dissemination

The TRC has produced a number of brochures, videos and informational materials on telemedicine which are made available to the general public upon request. These items are compiled into 'information packets' and distributed to anyone requesting information about our program. Information packets include brochures, newsletters, a project video, reprints, and articles written about our project. (Attachment 7 includes our brochure. Other items are pulled from Attachments 1-6 in this section.)

Lessons Learned

- Telemedicine should be driven by the need for service, not the love of technology. Perform a needs assessment before you begin planning a telemedicine program . If a program is not driven by need, participants will not be motivated to keep it going when external funding is no longer available. The needs assessment should include surveys of patients and families, primary care providers, and consultants. In addition, prepare cost estimates, cost projections, and cost benefit analyses to convince your hospital administrator or CFO that the program is economically viable and cost-acceptable.

- Address motivational issues for the specialists who participate in telemedicine. Most academic physicians have many clinical, educational, administrative, and research demands on their time already. Look for ways to integrate telemedicine into the consulting physician's existing clinical practice patterns. Keep video and computer equipment located as close to practitioners as possible; integrate teleconsults into physicians' existing patient schedules; tape instructions to all workstations and hardware; provide contact information for 24 x 7 technical support.

- Be an advocate for telemedicine in your own organization. Describe the benefits and experience of other programs that are fully operational and provide benchmarking data to back up your claims. Keep in mind that clinicians want to hear about clinical viability, while administrators may be concerned about the 'bottom line.'

- Don't assume that because you can offer a service, all rural hospitals will want or need that service. All small, rural, or underserved hospitals are not alike.

- Encourage all hospitals involved in a telemedicine network to select a 'telemedicine contact person' or liaison who can direct traffic for your program and with whom you can communicate on a regular basis. It gets very complicated when you have several hospitals in your network that all receive different services. Good communication with your remote sites is critical to the development of a strong and successful telemedicine program.

- Build on existing partnerships and affiliations when you plan a telemedicine network . It's difficult to maintain a telemedicine relationship when you don't have other mutual interests. For example, patient referrals, shared economic perspectives, and primary care training opportunities for academic medical centers might be some of the common goals that unite hospitals of disparate size and budgets.

- As an adjunct to the preceding recommendation, also keep in mind that the health care environment is volatile and in flux. Health care partnerships are continuously changing and evolving. Yesterday's partners may not be tomorrow's partners, and if a telemedicine contract has not been part of the relationship, have a contingency plan in place for building new alliances.

- Use the least bandwidth possible in developing your network, without compromising the speed and resolution you need to provide optimal patient care. Telecommunications is still the major expense for many telemedicine programs. Build a network that is scaleable, flexible, adaptable. Networks should be adaptable to changes in applications, services and advances in telecommunications technologies.

- Use your network and video conferencing for as many types applications as possible – clinical, educational, administrative. Because fixed costs (equipment) tend to be higher than variable costs (line utilization), the cost per use will go down as you use the system more. The costs saved to the institution by not having clinicians and administrators travel to remote clinics, attend distant meetings, and receive CME and CE will be substantial.

- Train end users (primary care providers, patients and , consultants) on the use of new technologies. Utilization may depend upon how well your target groups have been oriented and trained.

- Keep your end-users in mind with every decision you make. The technology is so complex and the number of participants so varied, it's easy to lose sight of what you are trying to accomplish -- improving access to health care.

- Work at the state and national level on policy issues relating to telemedicine. Reimbursement continues to be a major obstacle to incenting specialists to participate, especially with Medicare cuts impacting academic medical centers. Without an eye toward a workable business environment for telemedicine, improved health care for rural communities may never become a reality.

- Develop a business plan to ensure that your program is need-driven, economically viable, cost effective, and responsive to changes in the health care arena. Use the business plan to create a sustainable program when external startup monies are no longer available.

- Don't view telemedicine as top-down with the academic hub serving as the provider and the small hospital or clinic as the recipient of service. Primary care practitioners are playing an increasingly important role in the training of medical students for family medicine in the new managed care environment. View the telemedicine relationship as a mutually beneficial partnership and a collaboration.

- Standardize evaluation tools for telemedicine data collection. The evaluation process is already hindered by the small number of teleconsultations performed to date. Collaborate with other telemedicine programs to ensure that data collection techniques and surveys will yield maximum results. Begin collecting data and documenting processes at the very beginning of project planning and service implementation.

- Use timelines and provide regular updates when you're communicating with networked hospitals. Building a network is very labor-and time-intensive because of the number of people and issues involved. (E.g. local and long distance carriers, equipment and hardware vendors, hospital administrators and clinicians, local and national policy, the FCC, and so forth.) It may not look to others that little progress is being made, because so much of the effort is going on 'behind the scenes.'

- Communicate with other telemedicine service providers on a regular basis via phone, email, correspondence, or on-site visits. The number of issues that even seemingly disparate telemedicine programs share in common has been truly amazing. Identify telemedicine web sites, journals, publications, and presentations from which you can learn how others got their programs up and running. Visit telemedicine programs that appear to be similar in scope to your own and discuss how they overcame challenges and obstacles to implementation. There is no better way to learn about this complex environment than to share 'lessons learned.'

TELECOMMUNICATIONS SERVICES. PATRICK DUFFY, PROJECT MANAGER.

Telecommunications Services designed, installed and maintained the NLM Testbed utilized by contracts N01-LM-4-3511 (April, 1994 – December 1997) and N01-LM-6-3548 (October, 1996 – March, 2000). The NLM Testbed is an infrastructure that utilizes Wide Area Networking (WAN), Local Area Networking (LAN) and Compressed Video technologies in order to further the mission, goals and objectives of the two contracts. The Testbed, or Network's hub, is located at the University of Iowa Hospitals and Clinics, one of the nation's largest teaching hospitals. The institutions involved in this Telemedicine Network are connected via WAN and or video links to the hub.

<u>The National Laboratory for the Study of Rural Telemedicine</u>

Contract number NLM-N01-LM-4-3511, hereafter called NLM I, was awarded to the University of Iowa on April 1, 1994. Michael G. Kienzle, M.D., Associate Dean for Clinical Affairs was the Principal Investigator for the contract. This three-year telemedicine project initiated the establishment of the National Laboratory for the Study of Rural Telemedicine at The University of Iowa.

Projects funded by the NLM I Contract included:

- The Virtual Hospital
- Physiological Imaging
- Enhancing Access to Health Information
- Teleradiology
- Enhanced Communication for the Acute Care of Trauma in Rural Iowa.

Rural-Academic Integration: Iowa's Laboratory for the Study of Rural Telemedicine

Contract number NLM-N01-LM-6-3548, hereafter called NLM II, was awarded to the University of Iowa on September 30th, 1996. Michael G. Kienzle, M.D., Associate Dean for Clinical Affairs was also the Principal Investigator for this contract. The contract period was scheduled to expire September 30th, 1999, but was extended to March 1st, 2000, after receiving a six month no-cost extension.

This contract further utilized the testbed developed by the NLM I contract. Projects funded by the NLM II contract included:

- The Impact of Telemedicine on the Delivery of Psychiatric Services to Rural Areas
- Patient-Centered Multimedia Education for Individuals with Diabetes Mellitus: A Model for Chronic Disease Self-Management
- Specialized Interdisciplinary Team Care for Children with Disabilities and Consultations to their Community Service Providers
- Transmission and Interpretation of Pediatric Echocardiograms from Remote Sites
- Enhanced Communication for Acute Evaluation of Vascular Ischemia

Contract Reporting

NLM I Reporting. Telecommunications reports were submitted to the NLM on a quarterly and annual basis for the NLM I contract. These reports can be viewed electronically at the Telemedicine Resource Center's web site:
http://telemed.medicine.uiowa.edu/TRCDocs/publications.html.

NLM II Reporting. In addition to quarterly reports and a final report, NLM II Telecommunications accomplishments were summarized in a Phase I report, covering the period October 1, 1997 – September 30, 1997. A version without attachments is available electronically at the Telemedicine Resource Center's web site:
http://telemed.medicine.uiowa.edu/TRCDocs/Pubs/Reports/index.html.

Purpose of NLM II Final Report. The NLM II contract operated successfully on the infrastructure developed and maintained under the NLM I contract. This report focuses on new developments or information that has changed or been modified since the NLM I final report. Much of the NLM I infrastructure has been enhanced, new sub-projects were added, and video capabilities are now included in our network. Historical and background information obtained from the NLM I report will be included or summarized when appropriate. Lastly, a section on "lessons learned" will be expanded to include new observations and anecdotal information.

Institutional Overview

The University of Iowa Hospitals and Clinics, ranked as one of the best hospitals in the United States, partners with the UI College of Medicine to provide world-class patient care, health care education, and biomedical research to the people of Iowa and beyond.

This collaborative partnership, called University of Iowa Health Care, encompasses the expertise of highly trained specialists and the most sophisticated medical technologies available. Patient care is provided within 16 medical specialties by more than 1,200 physicians and dentists, 1,300 nurses and 4,300 other professional and support staff.

As one of the largest university-owned teaching hospitals in the nation, the UI Hospitals and Clinics annually records some 600,000 ambulatory clinic visits and over 40,000 patient admissions. During the past fiscal year, University of Iowa Health Care specialists provided medical care to 528,732 Iowans from all 99 counties, more than 42,800 patients from Illinois, 8,442 patients from other states, and 180 patients from other nations.

Pediatric services are provided through the Children's Hospital of Iowa, a state-of-the-art pediatric facility within the UI Hospitals and Clinics.

All patients receive personalized health care in a friendly, people-oriented environment that earns high rankings for the quality of care provided.

The UI Hospitals and Clinics has been named one of "America's Best Hospitals" by *U.S. News & World Report* magazine every year since the inception of the survey a decade ago. As well, a wide range of UI Hospitals and Clinics specialties are highly ranked.

More than 150 University of Iowa Health Care physicians – half the physicians listed for the entire state of Iowa – are included in the "The Best Doctors in America" database. This database identifies the best-trained, most experienced and skilled specialists in the United States.

Telecommunications Services --Departmental Introduction

UIHC Telecommunications Services (UIHC TS), headed by Director, Patrick Duffy, provides all telecommunications related services and applications at the University of Iowa Hospitals and Clinics and affiliated outreach areas. UIHC TS offers a complete range of telecommunications services supporting over 7,500 staff, 20,000 patients, visitors, vendors and others per day. UIHC TS is also responsible for supporting approximately 16,000 voice devices, over 3,900 radio pagers, and high-speed data services for over 8,500 end-user devices. In addition, they provide over 50 distinct services in the areas of voice, data, video, paging, telecommunications center, telecommunications management and consulting. See (Attachment 1) for details on all services.)

UIHC TS has an experienced staff of almost 50 full-time and contract employees, many of whom have contributed to the success of the NLM project (Attachment 2). The management staff on average have more than 15 years experience in the healthcare telecommunications industry. They have focused on providing telecommunications solutions designed to meet the diverse needs of healthcare providers, educators and researchers. In addition, these projects have provided them with broad experience and exposure ensuring that they are able to respond expeditiously to the rapidly changing healthcare environment.

The goals or purpose of the UIHC TS Department are:

- To provide the required telecommunications infrastructure and network necessary in an increasingly competitive and rapidly changing healthcare industry.

- To provide required services in an environment devoted not only to patient care, but also to teaching and research.

- To provide sufficient levels of redundancy in facilities and network to prevent loss of service due to an outage.

- To be a resource and facilitator in the development of new healthcare services and technologies utilizing telecommunications.

- To provide services and technical resources in a professional and cost-effective manner.

UIHC Telecommunications Environment

UIHC cabling facilities include a fiber and copper cable plant with two main distribution frames (MDF) that terminate over 60,000 cable pairs, 17 riser systems and 150 telecommunication closets. Currently, over 8,500 computers are connected to our high-speed data network. At the time of the NLM I contract, this infrastructure consisted of individual workstations utilizing Category 5 copper cabling connected to shared-media hubs. These hubs were connected via multimode fiber optic cable to a dual-homed FDDI ring for maximum redundancy and fault tolerance.

We have since migrated to a totally switched environment. Workstations are now connected with Level 6 or Level 7 copper cabling to 10/100 Ethernet switches. These edge or user switches have redundant OC-3 (155 Mbps) connections to approximately 50 distribution layer ATM switches. These distribution layer switches have multiple meshed OC-12 (62 Mbps) connections to a fully redundant backbone.

For the NLM project, the UIHC TS department supports over 10 remote sites throughout eastern Iowa. Remote locations are supported via multiple T1, Frame Relay, 56 K and Integrated Services Digital Network (ISDN) circuits.

NLM Project Involvement – General Overview

UIHC TS first became involved in the development of the National Laboratory for the Study of Rural Telemedicine in the Spring of 1994. The NLM II contract utilized the testbed infrastructure developed by the UIHC TS department for NLM I. TS staff were responsible for managing the infrastructure that enabled the projects to become active. This included network design, evaluation, testing, ordering, installation, maintenance, and monitoring and problem resolution. See Attachment 3 for details on services UIHC TS offers to remote sites including NLM sites. In addition to the services provided by UIHC TS staff, some initial testbed installation and support was provided by NEC. NEC is a maintenance vendor for UIHC TS and provides contracted voice, data and video support services.

Specific NLM Responsibilities for Telecommunications Services**:**

1. Plan, design, install the telemedicine network, including hubs, routers, switches, data service units (DSUs) and modems encompassing all data and video devices. Provide ongoing support, maintenance, repair and system administration.
2. Provide SNMP and RMON testbed management and system administration using a Netview/6000 station.
3. Provide technical and programming support to sub-projects and testbed users as required.
4. Monitor testbed infrastructure to ensure maximum availability. Troubleshoot hardware and software problems specifically related to telecommunications devices.
5. Provide on-going telecommunications training and instruction for sub-projects and testbed users as required.
6. Investigate new technologies and developments to meet contract needs, specifically those best employed in a rural setting.
7. Develop and maintain operational and maintenance procedures for all testbed telecommunications devices and related issues.
8. Work with telecommunication hardware and software vendors and carriers as required.

Other Resources Utilized by the NLM network

Iowa Communications Network. The Iowa Communications Network was utilized as a backbone for the connections to the rural hospitals established by the NLM telemedicine contract. The ICN is a statewide synchronous fiber optic network (SONET) with points of presence (POPs) in each of the states 99 counties.

The ICN was originally designed as a full motion video network with a focus on providing educational programming to state educational institutions and K-12 schools. From this initial charge, the ICN has expanded to offer these services to all state institutions, as well as public and private health care providers. Along the way, they began to offer long-distance services, switched video, data and Internet services. Recently, the ICN embarked on a 3-year project, converting the ICN network to ATM.

The UIHC utilizes the ICN for our full motion (DS3) and compressed (ISDN) video needs. We have also routed the majority of our long distance voice traffic over the ICN. Lastly, the ICN provides coordination and connectivity for all of our WAN (Wide Area Network) sites.

Installation Process

Original plans called for the connection of three sites via DS3 (45Mbps) links to the UIHC. A successful T1 (1.544Mbps) test at Ottumwa re-directed our focus. Discussions took place regarding the reduction of bandwidth from a DS3 to a T1 level. After a thorough review of the requirements and goals of the project, staff decided to seek a revision in the project protocol from the National Library of Medicine. The revision included changing connectivity from DS3 to T1, as well as adding sites to the network using the funds available due to the lesser costs of T1 circuits. The National Library of Medicine ultimately concurred with this opinion and granted the request.

Wide Area Network (WAN) connectivity decisions were made after evaluating all requirements necessary to support the required applications and projects at each site. Generally, sites doing video, imaging or large file transfers were candidates for dedicated T1 service, while the remainder could utilize Frame Relay. Sites requiring on-demand dial-up video conferencing were candidates for ISDN.

All WAN circuits utilized the Local Exchange Carrier (LEC) to supply the local loop connection from the remote hospital to the nearest ICN POP. Once at the ICN POP, circuit services were delivered via the ICN to the ICN POP at the UIHC and connected to the UIHC institutional network.

Product Evaluation, Selection and Ordering

The revision in the type of circuit to be used also made necessary a revision in plans for internal networking hardware. Accordingly, renewed vendor evaluations and product testing began taking place. Once design decisions were finalized, networking equipment was selected. Options were evaluated that would provide the most flexibility and expandability to support new or different technologies in a cost-effective manner that also ensured compatibility with existing institutional and industry standards.

After a thorough evaluation, vendors were selected and competitive bids were obtained for each piece of equipment. Products were then ordered from the lowest bidder. In some instances, the University was able to take advantage of existing State contracts with certain vendors. Vendors selected included: Cisco for routers, Cabletron for hubs, Kentrox for data service units (DSUs) for WAN connectivity, Ascend for multiplexors and Blackbox for remote monitoring equipment. These vendors met or exceeded existing UIHC TS connectivity requirements. In addition, at the time of the NLM I contract, each of these vendors was the current industry leader in their market segment. Finally, these vendors' products were already in use at the UIHC greatly reducing the cost of training, installation and ongoing support. See (Attachment 4) for details on vendors and products utilized.

Hardware Configurations

Product and vendor decisions gave us the opportunity to develop some initial standard cost and configuration profiles for each remote site. At the time of the NLM I contract the anticipated hardware cost for each site was approximately $18,000, while the monthly line charge were about $645. Due to vendor cost decreases, these rates have fallen since these first cost studies were completed. Attachment 5 shows the typical physical hardware configuration diagram for the remote site.

Staffing Issues

The NLM II contract proposal and funding was approved for two positions. A job description (Attachment 6) and advertisement (Attachment 7) were developed for a Network Specialist I (Computer Consultant II-PC7908). This position would provide Telemedicine and video project assistance. Three qualified candidates applied for this position and were interviewed. The position was offered to Mr. Jerrold Gilmere whose position began on May 19, 1997. A copy of Mr. Gilmere's resume can be seen in (Attachment 8).

An additional job description (Attachment 9) and advertisement (Attachment 10) were developed for a Network Specialist II (Project Analyst II-PC2409). This position would provide assistance for all LAN, WAN and Systems projects. Four qualified candidates applied for this position and were interviewed. The position was offered to Mr. Tom Bullers who started June 16, 1997. A copy of Mr. Bullers' resume can be seen at (Attachment 11).

Required Training

In order to successfully develop and deploy the testbed network, UIHC TS had to ensure that all of their technical staff had the proper training and experience. In this regard, UIHC TS developed an aggressive and thorough training program. Over the last six years, staff have participated in over 60 classes and over 1100 hours of training (Attachment 12).

Project Installation – Remote Sites

A projected installation calendar was developed for the entire project. Initial plans were to bring one site on-line per month. Based on this calendar, WAN circuits with specific due dates were ordered from the ICN and the LEC. From this information, a detailed installation plan and map was developed for each site.

Network equipment to be installed at the remote sites was first installed in a test bed environment at the UIHC for burn-in, programming and staging. The UIHC TS maintenance vendor installed the wiring at the remote site, or on-site staff was utilized. UIHC TS staff also worked with the ICN and the local telephone companies to extend, activate and test each WAN circuit.

Installation at the majority of these sites generally followed the same pattern. UIHC TS technicians installed all required workstation jacks, outlets, workstation wiring and blocks. A detailed wiring installation diagram (Attachment 15) was prepared and utilized to install network electronics at each site. Workstation wiring was attached to the Cabletron SEHI 10BaseT hub. This in turn was connected to a Cisco 2514 router, which was connected to a Kentrox DSU.

The carrier circuit was then extended from the LEC demarcation point to the Kentrox DSU WAN equipment. Blackbox remote monitoring equipment was then placed and connected to each of the above mentioned electronics. Finally, a local business line was ordered for each site and connected via a secure modem to the Blackbox equipment. (Attachments 16 and 17) represent a pictorial representation of the equipment installed at each remote site.

At the central site, each of the remote WAN circuits was terminated in a rack mounted Kentrox DSU and extended to a pre-assigned WAN interface on the Cisco 7000 NLM router. See (Attachment 18) for pictorial details of the central DSU rack.

The initial network of six remote sites and the central site were now completely functional. Upon completion of the installation process, each remote site was released to the University NLM Telemedicine Resource Center so that workstation and project installations could begin.

Central Site Installation

Before remote site installation could begin, all required equipment had to be installed at the central site. UIHC TS technicians installed and configured all required network electronics at the UIHC to support the NLM I contract. A Cisco 7000 router was installed and was directly connected to our institutional FDDI backbone with a second FDDI ring to support certain NLM computer resources such as the Virtual Hospital Server and the NLM Network Management System (Attachment 13). Lastly, the Cisco 7000 was designed to support up to 24 WAN connections. (Attachment 14) is a pictorial view of the front and back of the 7000 router.

UIHC TS technicians also installed two internal LAN segments to meet the needs of projects such as the Virtual Hospital sub-project. Separate FDDI and Ethernet segments were installed to meet the requirements of the Virtual Hospital and Teleradiology projects. Once UIHC networking resources were on-line, remote site installation began.

GSA (General Services Administration) Grant Sites

Based upon our success in getting the first 6 NLM remote sites operational, the Telemedicine Resource Center was successful in obtaining a General Services Administration (GSA) grant administered through the Iowa Communications Network. GSA provided us with funding to purchase WAN equipment for four additional sites (Burlington, Fairfield, Keokuk and Mt. Pleasant). Using the tools we had developed for the 6 NLM sites, we were able to quickly install the 4 GSA sites. A tentative GSA installation schedule was developed along with an installation worksheet. A new network diagram (Attachment 19) was then developed which showed all 10 remote sites.

Ongoing Monitoring

Moving from the implementation mode of this project into the operational or maintenance mode. UIHC TS established proactive monitoring and preventive maintenance procedures, statistical reporting structures and troubleshooting procedures. Network performance monitoring and alarm capabilities are available from the circuit providers (ICN, local telephone companies) as well as on the equipment installed by UIHC TS. In addition, NLM project servers such as The Virtual Hospital server provide performance information specific to their application. All of these tools were used for proactive monitoring and obtaining statistical information, and any combination could be used for troubleshooting purposes. From dealing with the relatively few cases of trouble on the network, our procedures have been tested "real-time" with good results. See the "Lessons Learned" section at the end for specific details on troubleshooting and problem resolution.

Monitoring Philosophy

Finding a cost effective and efficient way to monitor, manage and troubleshoot these sites became very critical due to the distance involved. For this reason, all equipment installed had the ability to send and receive SNMP messages. Using a redundant IBM RS/6000 Netview Management Station at the UIHC, we can remotely monitor the equipment in real time (Attachment 20). In the event of a problem or failure, an SNMP event or alarm is generated. Additionally, all WAN circuit failures generated an alarm.

In the event of a WAN circuit failure, we would be unable to communicate with the equipment over the WAN connection. The *Blackbox* equipment allows us to remotely and securely dial-in to each site, assess the status of each piece of equipment and make changes if necessary. The combination of "in-band" Netview management and "out-of-band" dial-up management resulted in significantly reduced downtime for the remote sites and reduced support costs.

Documentation

Effective monitoring would not be possible without accurate documentation. Extensive carrier documentation (Attachment 21) was developed for each site that contained key carrier information such as circuit ID, framing type and so on. Additionally, a remote site hardware matrix (Attachment 22) with definitions was prepared for all sites. Lastly, extensive records were created for each remote site (exhibit 23 through 42) that detailed the installation. Having this documentation on-line gave us the ability to easily make changes, as well as assisted us in quickly and effectively solving problems.

Maintenance

All internetworking equipment used at the UIHC is covered under standard maintenance agreements. Equipment from Cisco Systems and Cabletron Systems composes the majority of the hardware used on the UIHC network infrastructure and the NLM testbed. University discounts, spares and on-site trained technicians result in financial benefits to the NLM project. The total cost to the NLM for the UIHC and for each of the remote sites represents the actual amount charged by Cisco and Cabletron for these services

Spare Part Kit

Telecommunication Services keeps on hand a complete spare part kit for all internetworking hardware used internally or at remote sites. Key components are setup in hot-standby mode and made available 24 hours a day. In the event of a failure, the hot-standby spare can be quickly put into service to replace a damaged or failed component.

Financial Management

Telecommunications services has worked to keep costs down in the following ways:

1. Vendor installation fees were significantly reduced due to UIHC relationship with NEC. This resulted in extremely favorable pricing of $48 per hour versus $100 to $150 typically charged by telecommunications vendors.
2. UIHC Telecommunication Services provided over $50,000 for staff training in telemedicine and related technologies.
3. NLM related purchases received University of Iowa contract pricing on equipment and materials resulting in a 30% to 40% discount off of list price.
4. Over the past seven years, the UIHC has made a $15 million dollar commitment to build out the infrastructure so that telemedicine and related services might be supported.
5. The UIHC also invested $250,000 in a redundant management system that provides telemedicine services with active SNMP management of all LAN and WAN components.
6. $150,000 was spent by UIHC TS for fiber optic tools and network testing equipment.
7. Long distance charges were significantly reduced due to services being provided by Iowa Communications Network instead of combinations of local and long distance carriers.
8. Two Vans were purchased by a UIHC TS maintenance vendor to install and support NLM and GSA sites.

Wide Area Network Line Charges

This category represents the line charges billed by LECs such as USWest and GTE, and Long Distance (LD) carriers such as MCI and the Iowa Communications Network (ICN). These charges are necessary in order to provide WAN services to the 10 remote sites. In our standard configuration we have a T1 at 1.544 Mbps or a Frame Relay circuit at a Committed Information Rate (CIR) of 1 Mbps. Some of these sites have separate compressed video requirements necessitating a secondary T1 or PRI-ISDN circuit. A few sites with full motion video requirements are using DS3 connections. Finally, we have an analog line for remote dial up and diagnostics should an equipment failure or a WAN error occur.

Attachments 43-1 through 43-10 are an analysis of all T1 and Frame Relay WAN charges incurred by the 10 remote sites. Installation charges for the WAN circuits averaged almost $1,300 with a minimum of $970 and a maximum of $4,300. Average monthly charges were $1,278 with a minimum of $817 and a maximum of $2,078.

Installation of ISDN video circuits averaged over $1,500 with a minimum of $1,200 and a maximum of $1,826. Average monthly fees averaged almost $460 with a minimum of $168 and a maximum of almost $850.

Telecommunications Support for Video Services within UI Health Care – General

Historically, the University of Iowa Hospitals and Clinics (UIHC) Telecommunication Services Department has been involved in voice and data networking services. With the awarding of the first National Library of Medicine Contract for the study of rural telemedicine, the department expanded its services to include Wide Area Network technologies to support the remote data sites. With the second National Library of Medicine (NLM II) contract, digital video was introduced as a new element. Since the initial installation of three sites, the Integrated Services Digital Network (ISDN) telemedicine network has grown to include 35 medical sites that make regular use of the University of Iowa Hospitals and Clinics for distance learning, medical consultation, meetings, or staff training (Attachment 51).

Local Infrastructure

The first step was developing an infrastructure to support ISDN services for videoconferencing. The requirements for extending circuits throughout an institution were mapped out for remote installations. Van Buren County Hospital became the first test site for implementing this plan (Attachment 52). A wiring plan for extending the circuits inside UIHC was developed and implemented, establishing one telemedicine consultation room and one small conference room for test purposes. NEC Rollabout videoconferencing equipment was purchased and installed into these three sites (Attachments 53 and 54). Standard settings for the configuration of the codecs and inverse-multiplexers (I-mux) were developed to assist in troubleshooting (Attachments 55 and 56).

An infrastructure to support ISDN services for videoconferencing was needed at the University of Iowa Hospitals. Working with the Iowa Communication Network and building upon the concurrent work for the State Correctional project, ISDN Primary Rate Interface (PRI) circuits were ordered. The wiring technicians extended these circuits through the hospitals wiring infrastructure to bring the individual circuits to the assigned rooms. The circuits were then terminated at the I-mux attached to the codec.

Initial installation of circuits and videoconferencing rooms followed a one-to-one relationship. When an additional room was required, the wiring technicians developed a method for "swinging" a circuit from one point to another through the use of a patch block (Attachment 57). It wasn't long before this type of solution demonstrated a need for an improved distribution method that would allow for greater sharing of circuit resources without an attendant increase in manual operation.

Discussions with several other hospitals supporting video networks revealed possible avenues to explore. The requirements were 1) centralization of the circuit terminations; 2) remote management of the circuits for troubleshooting and monitoring of use; 3) sharing of the circuit resources by a larger number of rooms without manual intervention.

Testing and Vendor Selection

The search for a solution began with a close inspection of existing resources. Ascend products were being used for the videoconferencing inverse-multiplexers. Contact with Ascend representatives and literature review established that the Ascend MAX 4000, purchased as part of the initial ISDN installation, had a capacity that would allow for exactly the type of installation desired (Attachment 58). A testing plan was developed to establish the current operation and what would be needed to create the future distributed service plan.

Remote Protocol Modules (RPMs) were the first items that needed to be purchased to begin the testing. The current iteration of codec software was unable to handle the timing errors that the RPMs introduced into the network. NEC worked with Ascend to develop a revised software program to accommodate this problem. Once the software was developed and successfully tested with the RPMs, the green light was given to proceed with the implementation (Attachments 59 and 60).

Installation and Training

The new service would be located in the central switchroom of the hospital. Two existing PRIs were extended to this room. Two other PRIs already passed through the switchroom on their way to the medical consultation rooms. One medical consultation room and its attending PRI and the small conference room with its PRI were cut over to the new switch and RPMs and successfully tested for operation. The other consultation room PRI was cut over and RPMs installed after that. Finally, the US West PRI was attached to the MAX 4000 to complete the network installation (Attachment 61).

Additional rooms were added with 4-wire paths attached to RPMs at the MAX. As needed, a rollabout videoconferencing unit could be moved to one of these rooms. The RPM in the rollabout would be connected to the wall jack carrying the 4-wire path to the MAX and the services would be available to that room.

A description of the new network was distributed to the technicians responsible for the rooms. Practice on the switch operation was conducted by the NEC support technicians assigned to the hospital. The switch configuration and network specifications are stored in the technical documentation for the department (Attachment 62).

Evaluation and Modifications

Since the original creation of the distributed ISDN network, the MAX has received upgrades in its software and two additional expansion boards. One expansion board increased its capacity from 6 rooms to 12 rooms. The other board allows the MAX to distribute ISDN BRI circuits to users in the hospital. This latter service has not been exploited at the time of this report.

The distributed service network that has been created has provided exactly the level of service desired at the outset. It is possible to use any of the available circuits by any of the rooms. The number of rooms to number of circuits ratio has not been determined, but is premature at this point. The operation of the network has been transparent to the users. And, finally, troubleshooting has been made easier through the IP connection and control of the MAX from any computer located on the hospital LAN.

Hardin Library for the Health Sciences

One of the University of Iowa ICN classrooms is at the Hardin Library for the Health Sciences (HLHS). It is part of the area occupied by the Telemedicine Resource Center (TRC), established under the first NLM grant. It has been serving the DS3 videoconferencing needs of the medical college for three years. With the growth of compressed digital video for videoconferencing among healthcare institutions, it was determined that the ICN classroom should be adapted to handle communication using either technology. This project was undertaken with assistance from the College of Medicine for the distribution of instructional programming to medical residents across the state.

Using the state purchasing contract established for the Department of Corrections prison installations, NEC made a proposal for installation of a video codec and echo canceller into the HLHS ICN classroom. The cost and level of service met the needs of the College of Medicine and the order went out.

Installation and Training

Extended discussions were held with the University of Iowa Information Technology Services (ITS) on the process to have an ICN ISDN PRI extended through campus to the HLHS ICN classroom. As ITS had not entertained such a request in the past, the work was coordinated with the UIHC Telecommunication Services Department. By mid-summer, 1999, the circuit was completed to HLHS ICN classroom.

While the circuit extension was in the works, the NEC codec and Gentner were ordered for the installation. An Ascend VSX i-mux would come from the spares store of the UIHC TSD, saving the College of Medicine over $4500.00. Notes from the previous installation in the 8JPP ICN classroom were consulted and the plan for integrating the new equipment drawn up. ITS supplied wiring diagrams for the ICN classroom, which helped on the day of installation.
On July 16, 1999, the codec, Gentner and Ascend VSX were installed on a cart and connected to audio and video feeds out of the ICN equipment rack and to the ISDN wall jack (Attachment 68). As with the 8JPP ICN classroom, the ISDN codec outputs would not be integrated into the ICN classroom equipment. Rather, the remote site is seen and heard on a 27" Sony monitor mounted above the ISDN equipment on the cart (Attachment 69).

Operational Activities

Within a month of completion of the installation, sessions were being held in the HLHS ICN classroom over the ISDN circuit. Geriatric Department grand rounds, long held over the ICN DS3 network, are now offered over both DS3 and ISDN. Establishing parallel conferences in this manner has eliminated compatibility issues between DS3 and ISDN codecs. The only drawback is that the ISDN remote sites and DS3 remote sites cannot see each other.

Evaluation and Modifications

For the most part, the installation in HLHS has served well. Maintenance issues with the DS3 classroom equipment have arisen, due to the loss of the technical support person for the room. This is seen as a temporary issue, though. The major modification that is desired is to achieve a true link between the two systems, making the ISDN remote sites available to the DS3 remote sites. The planning for this is under way.

Telecommunications Support for NLM Contract N01-LM-6-3548: Specific Sub-Project Support

Telecommunications Support for Diabetes Education

Our experience in Telecommunications positioned us well to assist the Diabetes Patient Education project with designing a streaming video network and wide area communications. Staff from Telecommunications services became part of the Diabetes Team, providing assistance with other aspects of the project including Video Server Implementation, Web Development, and the varied challenges of a Patient Study.

One of the objectives of the Diabetes Education project was to develop a system that would provide high quality educational videos to patients, staff, and doctors in many areas of the UIHC and allow this content to be viewed at Grinnell Regional Medical Center. To accomplish this, a network was required that that would accommodate many high data rate video streams and provide assurances of limited data delay.

These requirements and constraints impose challenges to the design of a network. Traditional Ethernet networks can't provide multiple video streams without introducing delays, which result in poor video quality and garbled audio.

Additionally there needed to be a network link that allowed transfer of video content between the video server at UIHC and the server in Grinnell. Allowing the link to Grinnell to be ATM enabled, provided the ability to segregate large content transfers from interfering with other data transfers on the pre-existing T1 link. ATM enabling Grinnell link was considered a network design criterion for this reason.

At the initiation of the diabetes project, UIHC Telecommunications Services was in the process of evaluating advanced networking technologies for internal uses. Much of the groundwork in evaluating advanced network technologies was in process. ATM or Asynchronous Transfer Mode is a networking technology that is designed for high data rates and can guarantee limited data delay – it is ideal for video. Switched Ethernet is a technology that dedicates bandwidth for every end station – this helps to limit latency in content delivery. These classes of network were deemed appropriate technologies for evaluation in the Diabetes video application.

The following activities were conducted in the evaluation phase.
Evaluated switching products by Cisco (Catalyst 5000), Cabletron (MMac Plus), 3Com (Corebuilder 7000)
Consulted with product experts about the need for 100 Mbit vs. 10 Mbit Switched Ethernet
Attended demo of First Virtual and Thomsen ATM products
Consulted with vendors about conditions of purchase, product installation, and support
Requested product bids and quotes.

The 3Com Corebuilder 7000 and the 3Com Accessbuilder 9100 were selected. The product features were well matched to the needs of the project. The products performed well and we had a high degree of confidence in their design. Additionally, Communications Engineering Company (the integrator) was a company that we had worked with on many prior occasions and we were comfortable with their abilities and level of service. CEC also allowed us to work on a 60 day trial basis with the equipment. We would not be charged if the equipment didn't work as anticipated.

The following training activities were conducted to prepare for the network implementation.
UIHC Telecomm staff attended 3Com ATM Basics, CoreBuilder 7000 and ATM Testing and Troubleshooting training during the weeks of May 4th, May 11th and June 8th of 1998
3Com engineer joined staff due to UIHC's adoption of 3Com products in major network upgrade
Steve Schallau and Rick Deerberg each attended a week of advanced ATM training
Received installation and configuration assistance from CEC

Pre-installation Planning

Determining locations for deployment of the streaming video clients was difficult because it wasn't clear where patients would find these devices most accessible. It was determined that at least initially, patients would be able to visit 8th floor Patient and Visitor Center in John Pappajohn Pavilion to view the educational videos. It was expected too, that over time, UIHC network infrastructure upgrades would progress to the point where Switched ethernet would be available in at any location in the facility. Greg Easley and Tom Bullers to visited Grinnell to meet with patient educators and Grinnell IT staff to determine appropriate locations for video client placement.

All network installation locations were finalized (Attachment 44)
The UIHC SGI Video server would be installed in a rack on 8th floor adjacent to Greg Easley's office

- 100 Mbit Ethernet over fiber optic cable would connect the SGI to the Corebuilder in 8th floor
- The Corebuilder on 8th floor would connect to the UIHC shared Ethernet infrastructure
- The 9100 would be connected to an interface on Cisco N – our wide area network router
- The other side of the 9100 would be connected to the T1 interface to Grinnell

- In Grinnell the 9100 would be connected to the T1 and directly connected via Ethernet to the Corebuilder

In ATM training, it was discovered that an ATM module purchased with the UIHC Corebuilder was a limited performance model and caused backplane bandwidth to be reduced from 5 Gb/s to 2.5 Gb/s. UIHC Telecomm Services replaced this module out of parts stock. This increased the count of ATM interfaces on the Corebuilder and allowed it to operate at maximal bandwidth.

Additional Preinstallation activities included:
- Test bed was established in 8th floor closet to provide a facility for comparing video quality of Shared Ethernet vs. Switched 10 Mbit Ethernet, vs. 100 Mbit Switched Ethernet
- End to End testing of Corebuilder 7000s, 9100s using Ethernet and T1 emulation circuit was conducted by CEC
- Developed plan and check-off list to rollout Grinnell leg of network install. See (Attachment 45)
- Consulted with 3Com on-site engineer and NEC technicians for verification of installation procedure
- 3com On-site engineer prepped UIHC Corebuilder by programming IP addresses and installing latest firmware revision

The Grinnell leg of the network installation plan was carefully planned and reviewed. The completed network was modeled in house before installation in Grinnell. The plan was designed so that all IP addresses were correctly preprogrammed. At install, the only change was the substitution of the Grinnell T1 WAN link for the in house simulated T1. The Grinnell router would be removed and the existing Cabletron hub would remain to provide additional Ethernet capacity.

Installation

- The network installation activities were conducted in the following order.
- Corebuilder was installed in 8th floor closet and connected to UIHC infrastructure
- Multi-mode fiber optic cable was pulled into 8th floor to provide an ATM capable network connection for video server
- 5 network ports were installed on 8th floor in Greg's area to support his development equipment, video server, and test video client workstations
- Space was allocated on UIHC DSU/CSU rack and Accessbuilder 9100 was mounted and connected to Grinnell T1 span
- Tom Bullers and an NEC technician took an NEC vehicle to Grinnell to install the Corebuilder and 9100 (Attachment 46)
- The remote management system had to be reconfigured to operate at 19200 baud to accommodate baud rates of the Corebuilder and Accessbuilder
- The UPS in Grinnell was upgraded and environmental monitoring was added

Post Installation

The only problem in the installation was a difficulty with the new UPS. The monitored UPS system reported errors with its battery. This battery was replaced under warranty during a scheduled visit to Grinnell. Other than this small issue, the network has worked flawlessly. Network throughput was tested with six 1.5 Mbit simultaneous video streams. Video quality was excellent – no indication of dropped packets was detected. Content transfer between UIHC and Grinnell works well.

Since payment for the equipment was contingent upon successful evaluation, and because the products worked without flaw, follow up work included providing payment to the system integrator. It was discovered that a sole justification, as intended for the vendor would not satisfy accounting needs in this situation. We were able to get additional quotes from competing vendors and justified payment in this fashion. The purchasing process for networking components was completed on 8/26/98.

Evaluation of Set-top Boxes and Home Internet Devices

In the original project description the multimedia education experience both in home and hospital was to be delivered by low cost, low maintenance, multimedia appliances. It was thought that this device could be the same product for home and hospital. Discussions with vendors such as Apple, SGI, Sun, IBM, Oracle, Acorn, and nCube all indicated their eagerness for us to adopt their respective products. We wanted to select the product that would have broadest industry acceptance.

Evaluation Criteria

Greg Easley's initial goal was to implement a single device that could be purposed as an educational platform with a CD-Rom drive and used for dialup connectivity for web access in the home. This device would need to support popular Web browser features like Javascript, Java, Macromedia Director, and streaming MPEG video. Also, the device needed to be reliable and user friendly to minimize support effort at the home. The hospital device would additionally need the ability to over stream video over Ethernet.

Vendor Evaluations

Discussions with vendors such as Apple, SGI, Sun, IBM, Oracle, Acorn, and nCube all indicated an eagerness for us to adopt their respective products. However, after a prolonged period requesting evaluation units from these vendors, it became apparent that there would be many fewer products available than we had anticipated and the feature list would be restricted. Greg Easley decided that the home device and the hospital device would necessarily be different product.

Home Education Device

Shipping products that fulfilled the minimum requirements for a home device included the Bandai Pippin (Formerly Apple Pippin), and the Sony Web TV. Of these the Pippin looked most appealing because of its web browsing ability, built-in CD-Rom drive, and low cost. A Pippin was purchased in Late 1998 and evaluations began. The device was a simplified Macintosh running the Macintosh operating system. Greg demonstrated this system's web browsing ability at the NLM site visit on November 14, 1997. Content was formatted for the Pippin and work on developing interactive features with the device was begun. However, in early 1998 BANDAI announced that it was disbanding BANDAI Digital Entertainment and discontinuing manufacture of the Pippin device. This was unfortunate because it was superior to the other the available devices.

However, it was fortunate that a financial commitment hadn't been made on the device yet, but it applied pressure to quickly find a replacement platform. The Sony WebTV Plus was a remaining contender. It was backed by a large company, was designed as a consumer appliance, and its cost was less than the Pippin. Several of these devices were purchased and development for this platform began.

Hospital Streaming Video Platform

Telecommunications Services participated in the research, evaluation, and testing of viable streaming video clients. Products from many companies were examined. A great deal of product information was available on the Internet and discussions with vendors indicated strong support for MPEG streaming video over Ethernet. Initial focus was on determining which platform would become a dominant, well-supported platform in the market place. Further discussions with vendors revealed that products were still in development and features not fully defined. Repeated inquiries about hands-on evaluation with products did not yield results. We were optimistic when RCA-Thomson agreed to visit and give a product demonstration. They did provide a video demonstration but the products they used were not Ethernet based. Also their products were not compatible with SGI's streaming MPEG.

Following are some vendors that were researched for streaming video products.
Acorn http://www.acorn.com/acorn/
IBox http://www.i-box.com/
Microware http://www.microware.com
Stellar One http://www.stellar.com
Sun http://www.sun.com/
World Pippin http://www.atworld.net/
IBM http://www.internet.ibm.com

It soon became clear that this market niche that once seemed cluttered with competitors was not solidifying.

Because of the low cost of personal computers, and the quick advancement of web browser capabilities, set-top box manufactures appeared unable to make their specialized products competitive with PCs. Because of their closed architecture it was harder for products such as the Web TV to remain compliant with current web standards.

We then turned to looking at personal computers and particularly the recently announced iMac. Use of Silicon Graphics streaming video software on Macintoshes initially appeared problematic. Video quality was poorer than on Windows platforms. UIHC Telecomm staff worked with SGI in testing and optimizing the Mediabase client for use with Macintosh. After some driver refinements by SGI, streaming video quality became very good on the Mac. Ease of use, low maintenance, reasonable expense, visual appeal as a video kiosk platform, good performance, and software upgradability made the iMac stand out as a video platform. Telecommunications Services endorsed the adoption of the iMac as a video client for the Diabetes project.

Platform Usability Study

Because of concerns expressed previously by the NLM and in response to recurring web development issues with the WebTV, the Diabetes Team decided to do a platform comparison study, looking at end-user issues related to both the Web TV and iMac.

- A two pronged pilot study was performed to learn about user preferences for the WebTV and the iMac platforms. Volunteers viewed and interacted with identical material on the WebTV and iMac and then were surveyed to determine preferences. The second prong of the study was to rate the educational impact of each platform.
- Specific tasks conducted in preparation for the study follow
- Asked UIHC Volunteer Services for assistance with procuring subjects for pilot study
- Obtained services of instructional design graduate student to define testing standards
- Developed Features/Tools Comparison Matrix of Web TV and iMac platforms
- Received approval from campus Human Subject Office to proceed with study
- Set up iMac and WebTV for instructional design grad to use to learn task lists for both platforms.
- Obtained assistance from Dr. Wakefield for development of study process and survey instruments
- Developed pilot study criteria for platform comparison
- Developed pilot study task list and task matrix
- Applied for and received approval from human studies review board
- Developed pilot study survey instrument
- Recruited 50 volunteers
- Held study over a three day period
- Arranged for phones lines, Internet service provider accounts, computers, and facilities for testing
- Collected data for analysis (Attachment 47)

Execution of the usability study required the efforts and staff contributions of the Diabetes team, UIHC Telecommunications Services, the Telemedicine Resource Center, and the UIHC Volunteers office and assistance from University of Iowa Health Management. The results informed the decision as to device selection for patients homes and in hospital waiting rooms.

Final Selections

The iMac was chosen as the home device. It was the optimal home platform for many reasons. First of which was that the platform study indicated the iMac was easier to use and had more impact as an educational tool.

Secondly, the iMac met all the original selection criteria:
- CD-Rom drive
- Modem and Ethernet capabilities
- Support all web content standards
- User friendly
- Support streaming video

Finally, the iMac allowed for installation of software. This made the platform customizable to our needs. Also, the iMac supported standard, full featured, web browsers like Netscape and Internet Explorer. This allowed us to use standard web development tools like Adobe Go-Live. We could then focus on web development and not on workarounds for the idiosyncrasies of non-standard browsers.

Because we were able to develop for standard browsers, the web site could be made available to all PC users, not just people with our particular platform. Also the choice was governed by the simple fact that we all had good experiences with Macintoshes before, knew their capabilities, and were comfortable with their operation.

Video Server Implementation

Full motion video is an effective means to provide an educational experience. This study was contracted to help explore the effectiveness of movies using new video on demand technologies. Additionally, communications technologies can be incorporated that allow this material to be shared in even rural locations. This was the inspiration for the implementation of a video on demand system at the UIHC and Grinnell Regional Medical Center.

Initial work began on the video on demand server selection by conducting extensive product research. Greg Easley began looking at products from Oracle, nCube, IBM, First Virtual Corporation, and Silicon Graphics. Trips were made to Chicago and Cedar Rapids to partake in product demonstrations. Two servers would be purchased - one for UIHC and another for Grinnell. It was calculated that purchasing 2 servers would be less expensive than deploying one server and streaming video over the WAN link, given the high expensive of T1 circuits and the quantity of them required to support several video streams.

Selection criteria for the Streaming video server included:
- Ability to stream varying bit rate streams – from 28k to 3 Mbit
- Server administration needs to be easy and accessible from a remote computer
- Administration of video content needs to be simple
- Video content needs to be hyperlink-able from standard web pages
- Video server must have built-in web server
- Server must be robust and secure

Product selection was relatively direct. The Silicon Graphics Mediabase product running on Origin 200 hardware, seemed the most evolved product of all evaluated. It exceeded all selection criteria and compared very well to offering from other vendors. The product was ordered in the 2nd quarter of 1997.

System Installation and hardware maintenance
SGI engineers conducted initial server setup. Additional hardware configurations were necessary throughout the life of the system.

The following hardware updates were performed to the base system to accommodate performance, capacity, and serviceability needs.

- UIHC Purchased IBM vt100 terminals for the SGI servers at no cost to NLM
- Purchased and installed Fore Systems ATM NIC's (network interface cards)
- Purchased and installed APC UPS units
- Purchased and installed rack mount kits for SGI Servers
- Purchased and installed 2 additional hard drives for SGI video servers
- Purchased and installed Winsted 19" computer rack
- Purchased and installed DLT tape drive
- Purchased and installed 128 MB RAM upgrade for each server
- Installed primary video server in rack mounted, secure, power protected, and conditioned room
- Fixed Ethernet issue with video servers so they connect at 100 Mbit full duplex
- Replaced UPS unit because of failure in Grinnell
- Contacted SGI technical support to replace failed hard drive and restore data. Drive was replaced under warranty
- Motherboard and CPU was replaced under contract due to frequent system lockups
- Relocated SGI video server in hospital due to office space reallocation
- Installed streaming video server in Grinnell with remote access and remote reboot capabilities

Software Administration

Following is a list of software related administrative duties performed on the SGI servers
- Received authorization from SGI for beta program to evaluate Mediabase 3.0 beta 1, 2, and 3
- Mediabase servers were reconfigured with new domain names and added to the hospital Domain Name Servers
- New host names for the servers caused startup problems – a technical support case was opened and the problem was resolved
- Latest Mac streaming video player was installed and tested on same subnet as video server
- Software client was also tested on an adjacent subnet to assess the effects of router delay and network traffic
- Tested asset transfer capabilities on in house simulated T1 network
- Installed Mediabase version 3.0 final release on both video servers

- Worked on OS reinstallation/disaster recovery procedures with campus SGI representative
- Performed full systems backups for disaster recovery purposes
- Worked with campus SGI rep and SGI TAC to resolve Mac client installation problems
- Maintained user accounts for ftp access of video content
- Established Netscape Fastrack access control lists to prevent unauthorized access of video content.
- Upgraded Mediabase to version 3.1
- Did entire OS reinstallation as part of maintenance contract re-certification
- Obtained and installed compiler software from campus Varsity support contract
- Compiled and installed secure shell to allow secure remote administration
- Installed APC power monitoring software for graceful server shutdown during power outages
- Installed latest version of SGI operating system (Irix 6.5.3)
- Sought approval and ordered software upgrade to Mediabase 4.0
- Modified system console settings so terminal would operate at 19.2 Kbaud and inter-operate with remote access modem
- Added over 200 video clips into Mediabase
- Organized video clips into logical subfolders

Technical Support

Receiving timely and accurate technical support was the most challenging aspect of working with Silicon Graphics products. On two occasions installation dates were moved back or cancelled because of an inability for SGI's technical support to provide timely assistance. Additionally a considerable amount of time and expense was associated just with insuring that we had the correct support contract and were allowed to place technical support calls. A good deal of time was also spent working through the many channels at SGI seeking ways to improve the quality of tech support. These attempts at seeking better support were not fruitful. To compensate for the poor level of service it was necessary to redouble efforts to cultivate internal staff's technical skills.

Cineplex Application

(Note: This section is cross-referenced in the Diabetes Patient Education Report, Volume I.) Designs for the implementation of the hospital based patient education have evolved from original goals. Advancements in UIHC Telecommunications Services infrastructure allowed video clients to be placed nearly anywhere in the facility. It was no longer necessary to have a separate "Diabetes Network". Also the notion of using existing PCs for delivery of educational material was adopted by the Diabetes team. Additionally, a broader range of subject matter was considered for eventual delivery over the Cineplex system. In addition to Diabetes materials, hospital training materials, video tapes on heart disease, and CPR were digitized and placed on the video servers.

The Diabetes Team determined that the efficacy of streaming video as an educational medium would eventually be evaluated by giving a short test before showing streaming videos to a participant and then again after. The pre-test and post-test could be administered directly on a web based form.

Greg Easley developed a graphically engaging prototype of a web based interface dubbed "Cineplex." Additional work was necessary to make the interface dynamic and allow participants to browse and pick from the full list of videos. Another desired improvement was the placement of the movie player window directly into the web browser "canvas". The default behavior for the video player was to display on the video in a floating, closeable, window. This window, by inexperienced users might be dragged off screen or obscured entirely by other windows on the screen. Embedding the video on the web page allows better control of what the user sees and provides guarantees that the user will see the presented video.

Developing this ability to embed video on the web page proved to be an involved undertaking. In this regard, the Diabetes Team:

- Developed graphically engaging working prototype of streaming video web interface — Cineplex
- Implemented on test web server then arranged to post to production site on College of Medicine server
- Augmented graphical main pages with a prototype "video picker"
- Researched best way to develop dynamically generated video picker
- Java applet using Quicktime for Java library and connection to ODBC database
- Authorware system
- Cold Fusion with Javascript front end
- Perl and ODBC database
- Developed Authorware based prototype for pre and post test for hospital video server implementation
- Development on Cineplex graphical interface continues
- Investigated related medical/educational applications of video server capabilities.
- clinic based streaming video system for providing education on proper echocardiogram technique
- Application to provide hospital wide streaming educational videos on mandatory reporting of child abuse
- Application to provide hospital wide streaming of CPR educational videos
- Educate hospital staff on proper fire safety techniques

Video Production

The Diabetes Team produced over 30 hours of Diabetes oriented educational videos. (For a sample, please refer to Volume IV, Project Videos, "Cineplex.") Much of the footage was of medical experts discussing various aspects of diabetes. Also a very successful "group encounter" was shot by Bryan Sheeley which featured Diabetics and their spouses discussing living with the disease. Ben Franzen had the unique idea of visiting a diabetes camp where his sister happened to be counseling. He was able to get hours and hours of priceless footage of children relating their experiences with diabetes. (Please see Cineplex video in Volume IV of this Report.)

Post-production was accomplished on the Media100 non-linear editing system. This system was an invaluable tool in preparing the footage for incorporation with the web site and the streaming video server. The only limitation of the system seemed to be the time it took to compress the footage into a Quicktime movie. However, to overcome this, the students were able to use the Minerva MPEG encoder to process the movies in real time. Movies were then processed with Media Cleaner Pro to clean and flatten the movies.

The Media 100 system was not without its problems, however. It is a complicated system and required a fair amount of maintenance. We experienced problems with the hard drive array and problems with SCSI cable failures. Software was upgraded several times on the system and a hardware upgrade was performed too. As can be anticipated, digitizing video requires enormous amounts of disk space. Getting enough storage space to accommodate all the capture footage was a continual struggle. Telecommunications Service's donation of a 70 GB DLT drive helped enormously in providing enough file space and to provide disaster recoverability.

Web Development

Creation of a web site was central to the role of providing patient education for the at-home component of this project. The web content would be adapted from materials culled from Vicky Kraus, RN and Dr. John Macindoe's existing Diabetes education classes. This would form the core content of the site. Also intended for the site were interactive features to allow patients to communicate. We intended this for interactive capability to foster a sense of community amongst the participants.

Staffing

On February 2nd, 1999, the web designer / programming position was filled by Bryan Sheeley who had the most experience in video production and multimedia development of all the candidates (Attachment 48).

Student video technicians were hired to assist with video production. They have been a huge help and were able to work independently to direct, shoot, and produce the educational video footage. Ben Franzen was hired in March, 1999. Ross Shebek was hired in April of '99. Kent Lambert was hired in August off '99 when Ross left for another job.

The momentum generated by acquiring new staff was short lived because of Greg Easley's departure in June of '99. The Diabetes Project Director, Dr. John Macindoe left the project in November of 1999. Remaining members on the Diabetes team were Vicki Kraus, RN, Dr. William Sivitz, Tom Bullers, and Bryan Sheeley.

Pre-production Planning

In addition to the difficulties imposed by staff turnover, repeated platform changes required delayed web content development. After each change, all web content had to be recoded. Bryan Sheeley came on shortly before Greg Easley's departure. Bryan took on the task of reviewing available materials with Vicky Kraus, Bill Sivitz, and Dr. Macindoe. He generated a Site map that was repeatedly reviewed by the clinicians. Bryan also met with Sidney Carlson to discuss content for the Diet & Nutrition section of the site. Bryan used the enhanced capabilities of Adobe Go-Live to design a logical layout that allowed for easy navigation in the web site.

Web Page Creation

Bryan Sheeley worked with the physicians developing content in an iterative code and review process. Tom Bullers assisted with hand coding web pages and resolving problems with the site. He also used Cold Fusion to developed database populated pages and a web based email form.

Go-Live proved to be an efficient tool for site development. The principle investigators and content specialist Vicki Kraus, R.N., reviewed all text associated with the diabetes management web site. This step was undertaken so that content would reflect recent changes in ADA guidelines as well as recently published research. The site interface was revised to allow for more direct navigation. Attention was paid to developing the site with large legible type to accommodate patients with poor vision.

Web Server Administration

Windows NT based Internet Information Server was used as the test web server. UIHC Telecommunications Services provided a PC to host this test web site. Tom arranged with College of Medicine to host the production version of the site. This proved to be a very good working arrangement. Posting to the test web site allowed for quick and easy modifications and flexible trials of new features. Allowing College of Medicine's administrators to host the production web site relieved us from tape backup and maintenance related issues of web server administration.

Allaire Cold Fusion middleware was used for active page development. A web based message board was incorporated into the site as well. Several different freely downloadable threaded messaging software programs were evaluated and installed until we settled on a product that worked well and provided a reasonably simple installation procedure. Using an NT based web server complicated the process of using freely available Custom Gateway Interface (CGI) based applications. In cases like these, Unix web servers provide easier integration of Perl based CGI applications.

Video to Home

During the course of the web development a great deal of diabetes video footage was collected. It was intended that this footage be available to home users as well as patients in the hospital. Streaming video codecs continue to improve and we had heard particularly good things about the Sorenson Quicktime codec. Using this codec we believed that this diabetes footage could be compressed to the point where it would be possible to stream to home users over a dialup connection and provide decent image quality.

To provide streaming video to the home we set up a Quicktime Streaming video server. The SGI server did not support Quicktime then. Quicktime Streaming Server had just begun to ship with Apple's OS/X server product. Mac OS/X cost $250. We set this software up on a Mac G3 to evaluate. The software is all Unix based so it takes some effort to install and use. Unfortunately we discovered that even with these advanced codecs streaming video over dialup speeds proved impractical for our educational application. The get acceptable frame rate at dialup speeds, the picture size had to be reduced to the point of diminishing its educational value.

However, the evaluation of this product was very successful in the sense that it opened up many new possibilities to us. This product though not able to stream quality video over dialup, provides image quality that surpasses what is available on the SGI product. Quicktime is a format not currently available on the SGI, that is very flexible, and provides many capabilities to developers that aren't possible with simple MPEG.

Home streaming evaluation tasks:
- Purchased SCSI card and 2 SCSI drives to support home streaming video
- Installed new hardware and OS/X server in Apple G3 computer
- Applied software upgrades and service packs to OS/X
- Used Media Cleaner Pro to convert existing content into format for streaming to home
- Experimented with many different settings to provide best quality at modem level rates
- Tested video streams over dialup connection using an iMac
- Found that picture size was too small and quality was not good enough at dial-up level bit rates
- Decided on alternate plan to provide video content on hard drive by developing a Video Vault movie interface

Patient Study

The ultimate goal of developing a web site, producing video, and selecting a multimedia platform was to provide the educational experience in the home. By the end of October, all revisions of the web site content were completed and approved by the Principal Investigators. Post-production of diabetes video content started in October and was completed by mid-November in anticipation of the beginning of our in-home study. The next order of business was recruitment of subjects.

Recruiting

Early in October, Dr. Sivitz, Vicki Kraus, and Bryan Sheeley traveled to Grinnell to meet with members of the Grinnell Diabetes team and members of a diabetes education support group. This provided an opportunity to explain the project, answer questions, and begin the recruiting process.

In late October, physicians and staff from Grinnell Regional Medical Center were asked to serve as consultants. Dustin Arnold, D.O., Dan Anderson, M.D., and Karole Conaway, RN, agreed to participate. Karole Conaway, Diabetes Patient Education Coordinator at Grinnell, led the effort to recruit 32 diabetes patients for the study.

A recruiting criteria handout was designed and published to explain the project, and qualification requirements to potential study applicants. Ms. Conaway was provided several hundred copies that she mailed to a large patient pool, and distributed in clinic areas in the Grinnell Regional Medical Center.

Initially, 26 patients agreed to participate and attend a kickoff meeting on December 2, 1999. Each participant signed a release form, had a blood sample taken for Hemoglobin A1c, completed pre-tests, had their height and weight taken, and were randomized into two groups. The first (study) group would receive the iMac computers in their homes while the second group would serve as a control group. The control group would receive whatever form of traditional patient education they acquired in the past. The iMac group then returned to the medical center on Saturday, December 4th for a one-day training session on the fundamentals of the iMac and the resources made available to them in our study.

A week later Karole Conaway informed us that she had recruited nine additional patients. Ultimately seven of these patients joined the study, were randomized the same way, and then assigned to the iMac or control group. Those who were randomized to the iMac group were provided the same one-day training session on December 18, 1999. At this session we also distributed printers and installation training to the entire iMac group.

Technical Preparations

To accommodate the in-home study, significant logistical and technical planning was required. The technical preparations, user training, and subsequent distribution of the iMacs proved to be one of the most challenging aspects of the study to date.

Remote Access

After researching three different systems, we installed the Shiva System and purchased four modems to support up to 16 users. (Attachment 49). One benefit of the product was that we had institutional access to this product and were familiar with its use. Another benefit was its ability to provide real-time logging of patient access.

We established a long distance account with an 800 number for our long distance connection to the server modems. Our study participants originated from 14 different communities spanning six counties, and seven participants from the iMac group required long distance dial up.

E-Mail

Establishing e-mail accounts for the study participants proved to be particularly challenging. The problem was we had no idea which participants would be selected for the iMacs until two days before we sent them home with the computer. It was clear we needed an e-mail system that would give us the ability to quickly access and administer changes to user accounts. The solution was our campus UNIX e-mail system. This allowed us to quickly establish 20 generic accounts and a distribution list with the campus list server. Tom was assigned administrative rights that in turn gave him access to make the last minute changes.

Another facet of our e-mail support initiative involved the development of a web-based form that allowed our users to selectively choose multiple members from a mailing or "pick" list and then send a message to the selected group. Typical web-based solutions don't provide this capability. We researched CGI and JavaScript options, but chose to build a solution in Cold Fusion. While this solved the problem, we continue to monitor the system's use and effectiveness.

iMac Preparation

Considerable thought went into devising a streamlined process to prepare 16 iMacs for the study. We identified all software components that would make up the iMac profile, and agreed upon a two-phase approach to building out each machine. Phase I involved inspecting each machine, installing a RAM upgrade, and updating the firmware.

These steps were followed by the installation of:
- Apple's newest operating system – Mac OS 9
- Microsoft Internet Explorer 4.5
- Microsoft Outlook Express
- Timbuktu Pro
- Starbright Diabetes Education CD-ROM

These were the fundamental components installed and tested on each iMac before proceeding to Phase II. To expedite the configuration process, we utilized a free software tool called Revrdist. This allowed a single iMac system "image" to be created then cloned to all the other iMacs over a network.

A separate iMac NLM support kit was created and packaged with each iMac.

The iMac support kit included:
- color-coded surge protector
- two color-coded phone cables
- a dual-outlet phone adapter
- a grounded power cord adapter
- an instructional video for iMac set up
- a mouse pad
- a Starbright Diabetes Education CD-ROM.

This kit was created to help study participants with the set up of their iMac.

Phase II was performed the night before the training session at Grinnell Regional Medical Center. All iMacs were unloaded and moved to the training room. All training support equipment was also unloaded and eventually set up for the following day's training session. Each iMac required individual configuration of the components installed and tested in Phase I. This process was expedited by the installation of an Ethernet Hub and using one iMac as a file server. Phase II required 4 people working approximately nine hours, including travel time. (Attachment 50)

To configure each iMac we used the following checklist:

- iMac Configuration Checklist
- Assign iMac to study participant; label the iMac, the box, and the iMac NLM support kit.
- Establish and confirm E-mail account for iMac and user; make necessary changes in the Internet set up and Microsoft Outlook Express preferences.
- Create Remote Access Settings for Ethernet (Grinnell Training) and Home Dial Up; test changes, save settings, and test analog dial-up.
- Determine if iMac user will require long distance dial up; configure dial-up string accordingly in Remote Access Settings.
- Set Remote Access Option setting for "Connect automatically when using TCP/IP applications."
- Copy Video Vault web application to local drives of every iMac. Create custom icon and alias for Video Vault, place alias in Launcher items folder in the system folder. Make sure icon appears in launcher window.
- Add Timbuktu alias to the desktop and place copy in the Launcher Items folder in the system folder. Enable Timbuktu Pro in the Extensions Manager. Check to make sure Timbuktu appears in launcher window.
- Create New Address book in Timbuktu for each member of the diabetes technical support team.
- Make sure that the iMac has correct Launcher window configuration. Should have icons for Remote Access, Microsoft Outlook Express, Internet Explorer, Timbuktu, Video Vault, Search, and the Starbright CD.
- Disable Time Synchronizer and Location Manager in Extensions Manager.
- Test for local access dial up (we need to have the 9 in the dial string). Remember to remove the 9 prior to shutting down and re-packing the iMac.

Training

A training outline was created with a heavy emphasis on hands-on activity. With a presumption of a wide variation among users on computer competency, it was considered important that each user demonstrate operating skills before leaving the training room. The home activities that the volunteers would perform were broken down into basic competencies. These were introduced, demonstrated, and practiced during the course of training.

The study was introduced and the training proceeded through the use of a moderated PowerPoint presentation, viewing the set up videotape, and guided practice on their personalized iMac computers. Exercises included powering on the computers, launching applications, navigation of the NLM Diabetes web site, live web searches, and sending and receiving e-mail messages. Technical support contacts and local medical support links were introduced.

The entire training process was scheduled for 9 a.m. to 3 p.m. This included two breaks and a catered meal for the study participants. Two training sessions were required to accommodate 12 study participants.

User Support

On-going technical support is available to the study participants via e-mail and the forum, both accessible on the web site. A technical support line is monitored Monday through Friday from 8 a.m. to 5 p.m. This technical support line is a toll-free 1/800 number that rings into the Telemedicine Resource Center and then is transferred to diabetes project staff. A voice mail system handles calls in the evenings and on weekends.

Another method of support is the ability to establish a direct connection between our support staff and the end user's iMac using Timbuktu Pro. Timbuktu allows support staff to direct the iMac of a remote user. This helps us identify, and when possible, repair the problem without extensive travel.

We have established a web based call logging system and database to track the number of calls, their severity, and steps that were taken to resolve the problem. We also have the ability to monitor user activity and maintain a strict level of confidentiality for the study participant.

Current Status

At the time of this writing, it has been approximately one and one half months since the initial randomization of the subjects. Another group meeting will be held three months after initial randomization. At that time, weight will be again measured to determine body mass index, the knowledge questionnaire will be administered again, and blood samples obtained to measure hemoglobin A1c. The computer use group will complete a follow-up computer use survey. The groups will then crossover. Those subjects who did not use the computer for the initial three months will receive training. They will be given the iMac computers for a three-month period and, as before, web site use will be monitored. Those subjects who used the computer for the first three months will continue to be followed for three subsequent months. After this second three-month period, all subjects will again be administered the knowledge questionnaire, body mass index determined, and hemoglobin A1c again measured. The group who used the computer the second three months will complete the follow-up computer use survey.
The results over the first three months of the study will determine the increment in knowledge as well as differences in glycemic control and body mass index between the two groups.

Over the second three months, Dr. Sivitz and Vicki Kraus, RN, will determine whether prior control subjects will improve glycemic control having been given computer use. For the control group (computer users over the first three months), we will determine whether knowledge, glycemic control, and any potential change in body mass index will be sustained. The final crossover study will be completed the end of May, thanks to extension funding from The University of Iowa. Data analysis will be completed in early summer, 2000 and the results will be forwarded to the NLM.

Telecommunications Support for Pediatric Cardiology

This sub-project evaluated whether pediatric echocardiology studies can be transmitted between remote sites and still be used to arrive at a proper diagnosis. In a rural state, the response time for emergency cardiology studies and the reading of relatively routine echoes can run between 24 hours to one week depending upon whether the study is delivered via courier (an expensive mode) or regular parcel delivery systems. The medium used for the echo studies is super VHS video recordings.

This project began as a data transfer project. The echo studies would be digitized, stored as files, and transferred between sites over high-speed dial-up circuits. This would be compared to live studies transferred over the Iowa Communications Network fiber optic circuits and to the traditional VHS videotape studies delivered via Fed Ex or courier.

Early in the process of researching a viable Store-and-Forward solution, the size of the pediatric echo studies dictated a re-thinking. To transfer the resulting files in anything short of an hour, the circuit would need to be at least a T-1 (Attachment 100). Compressed, digital videoconferencing emerged as the more promising avenue to explore (Attachment 101).
The video system selected would need to operate over a dialable ISDN network. The bandwidth needed to transmit "live" S-VHS playback would be at least 768kbps (12 channels) and may need to be as high as 1472kbps (23 channels). The systems would need to be user friendly with a speed dial and graphic user interface. The final price would have to allow for installation at one remote site and one site at UIHC Pediatric Cardiology, at a minimum (Attachment 102).
Three vendors submitted proposals, with the winning submission meeting project spending limitations and delivering usable video quality for the study. Communication Engineering Company, with an office in Iowa City, proposed using a PC ISA card codec as the heart of the system. The workstation would be mobile, house a UPS for power conditioning, and a high-quality VCR with time base corrector. As it was PC based, it also held the promise of allowing for file transfers. All of this at an average workstation price of $22,000, about half that of the other two offerings (Attachment 103).

The two units were delivered to the UIHC in October of 1997 by CEC. The next month was spent in testing the operation of the units. Calls were attempted using two PRI circuits available in the Pomerantz switchroom. The quality of the video resolution, color saturation, and frame rate were tested against a standard pediatric echo study to make sure that the best overall product was transmitted and received.

During the course of testing several obstacles emerged and were overcome. The first obstacle was the non-standard nature of the S-VHS recording that came off the echocardiology

instrument. The initial selection of VCR and time base corrector (TBC) proved to be inadequate for the task. A different VCR was selected as a replacement.
The second major obstacle was that during the course of testing, we were unable to attain the bandwidth desired for the calls through the circuits available. Troubleshooting of the circuits by US West and ICN technicians revealed that there was a traffic bottleneck between Iowa City and Cedar Rapids. Our testing, utilizing up to 2.8Mbps in bandwidth, was fully occupying half of the available phone circuits between the two cities. US West quickly upgraded this bottleneck so that we were no longer knocking out vital commercial transactions that required dial-up connections to complete transactions. The final product was now ready to be installed at the sites (Attachment 104).

Due to the cost savings provided by the Zydacron-based workstation, the project was able to plan on two remote sites and one local site, rather than the single remote site in the original proposal. Genesis Hospital, East Campus, in Davenport, was selected to receive the first remote unit. St. Luke's Regional Medical Center, Sioux City, would receive the second remote unit, after an initial testing period had been held with the first installation (Attachments 105 and 106).
An on-site meeting was held in Davenport at Genesis East on August 13, 1997, to assess the site, identify contact people, and prepare the site for wiring installation. Digital pictures were taken to document the installation site.

The ICN supplied PRI was ordered and site surveys took place for the installation in mid September, 1997. Once the circuit was installed, UIHC technicians extended the circuit to the cardiology room in Genesis.

Training was conducted on November 4 at the University of Iowa Hospitals. Two Genesis staff members and seven UIHC staff attended this training. It was conducted by Rob Olson, CEC video engineer.

The video workstations were installed at the Genesis East echo lab and at UIHC Peds Echo Lab in the second week of November, 1997. On-site training and practice was conducted at Genesis East with the cardiology lead nurse at the time of installation. A simplified set of instructions were created for each site to help initiate calls and shut down the workstation (Attachments 107, 108, 109). The first transmission of a pediatric echo took place that day. As a side fact, the diagnosis changed based on the information transmitted, resulting in a significant change in family counseling and treatment procedure being prescribed.

A similar installation procedure was followed for St. Luke's RMC. The major exceptions were that the internal wiring was done through sub-contracting with US West (Attachment 110). The workstation was also in the process of being upgraded at the time of the installation. To meet a self-imposed deadline, the UIHC workstation was packed and shipped to St. Luke's for their installation, while an NEC TeleDoc was temporarily installed at the UIHC (Attachment 111).
To accommodate the change in equipment, the UIHC staff underwent new training for call reception and recording. Additional support materials were generated to aid in the training (Attachments 112, 113). Once the third workstation was ready, it replaced the TeleDoc at the UIHC and the project was back into full swing.

Over the course of two years over 120 pediatric echoes were transmitted to UIHC over the compressed digital video system. The Zydacron codecs performed fairly well, requiring no maintenance. The only major complaint has been in the call generation, when it takes several attempts to get a call connected between the two sites.

A trouble ticket was generated with Zydacron in the summer of 1998 to address the call connection problem. This was escalated to include Ascend Corporation's technical support team. After a month of research and testing by the two companies, a software fix was created by Zydacron and downloaded into the operation software (Attachment 114). Call generation configurations were also modified. As a result, Telecommunication personnel are less likely to receive a page concerning making a connection for a pediatric echo transmission than had been true in the past.

While the initial system design worked for transmission of echo studies, there was area for improvement. Field use demonstrated several deficiencies in the original design. Steps were taken almost immediately to make the necessary changes.

The original design called for a 20" monitor to view the echo study as it was transmitted. The standard viewing monitor used in reading the studies is a high-resolution 14" Sony. The 20" Sony monitors did not have comparable resolution, even though they had similar specifications. These were eventually replaced for the smaller 14" models.

A second design change was to decrease the size of the UPS. The original UPS was designed to keep all the equipment in operation for up to 30 minutes in the event of a power failure. This included the 20" monitor. The new design took into account the fact that, in the event of a power failure, there would be no transmission, and specified a UPS that protected the computer and circuit equipment from power spikes and other voltage fluctuations, but not the video equipment. This resulted in a large savings of weight and bulk inside the rolling cart that housed the workstation.

With the growth of compressed video networks at other hospitals in the state, a further expansion of the project became possible. Pediatric cardiology services were being requested in northeast Iowa at Mercy Hospital in Dubuque. Mercy is equipped with a V-TEL conferencing unit through their affiliation with the Mercy Health System. Their inclusion into the project was researched and was found to be practicable (Attachment 115).
A site visit was conducted in October of 1998 to meet with the administration and cardiology staff. The existing conferencing and circuit equipment were also examined at that time. Communication was exchanged with the Mercy Health System's central office in Farmington Hills, Michigan, to receive permission to go ahead with the activity. This was affirmed and the process began.

An ICN PRI was ordered and installed at the hospital. This was terminated at their existing Ascend Multiband Plus I-mux. The Ascend was programmed to access both PRIs (knowledge gained through the activity of working with the Ascend MAX at the UIHC) and to make either circuit available to the V-TEL codec. Changes were made to the V-TEL configuration to accommodate a VCR and to address calls to the appropriate PRI. To communicate at the bandwidths needed for echo transmissions, the software in the codec was upgraded to the latest version by a representative from Norstan Corporation. When everything was in place, training of the medical staff at Mercy was held, via videoconference, on June 25, 1999.

Pediatric echoes have been transmitted at a variety of bandwidths, over a variety of systems, over the course of the two years of the study. The quality of the transmissions have proven to be diagnostically useable, but even better, the service appears to meet the need of providing rapid response when children are in need. Service to Mason City required only the addition of a VCR to their existing CLI-based codec to make their site capable of echo transmissions. This means that the pediatric echo project is ready to roll out to over 50 sites in the state of Iowa with little additional fanfare.

Another expansion of the project is to equip the conference room at the UIHC Pediatric Cardiology Department to enable videoconferencing to other cardiologists around the state. This capability will allow on-going training, "face-to-face" consultations with primary care physicians and families of patients, and to provide another location for grand rounds delivery at UIHC (Attachment 116). Plans have been drawn up and money for the project is being gathered.

<u>Telecommunications support for The Impact of Telemedicine on the Delivery of Psychiatric Services to Rural Areas</u>

Support for this sub-project required setting up compressed, digital videoconferencing sites at two rural Iowa hospitals and a connecting consultation room at UIHC. Van Buren County Hospital (VBH) in Keosauqua, and Washington County Hospital (WCH) in Washington were selected as the test sites. For the first year of the study, VBH would be the tele-psychiatry site with WCH acting as the control site. The roles would reverse in year two.

Through the efforts of the Iowa Communication Network, US West, and Van Buren County Telco, ISDN PRI circuits were extended to VBH and UIHC in year one. An NEC TeleDoc was installed at VBH and an NEC Rollabout as installed at UIHC. Planning then began for the later addition of videoconferencing services at the WCH site.

At the end of 1997, the ISDN PRI circuit was ordered for WCH through the efforts of the ICN and GTE North. An NEC TeleDoc was installed at the WCH site early in 1998 in preparation for the switch-over of psychiatric services. WCH was in the process of a major construction effort, so the equipment was relocated in December of 1998 without interrupting the course of the study.

<u>Telecommunications Support for Specialized Interdisciplinary Team Care for Children with Disabilities and Consultations to Their Community Service Providers</u>

This sub-project studied the impact of the delivery of services via uncompressed videoconferencing between the University Hospital Schools and the rural schools and local communities of the children in need of these services. The state of Iowa was establishing a fiber optic network, the Iowa Communication Network, which would serve as the carrier for the videoconferences.

Support for this project involved provisioning Iowa Communication Network (ICN) fiber optic service to the University Hospital Schools (UHS) facility. Two locations were established at UHS as ICN classrooms. Fiber and copper paths were laid to connect to both the University of Iowa ICN Point of Presence (POP) and the University of Iowa Hospitals POP. The use of redundant pathways allows the UHS classroom to operate over either pathway depending upon availability.

The ICN classroom network allows for two-way interactive videoconferencing in an uncompressed, full-motion environment. It links 689 classrooms across the state of Iowa, including about 450 K-12 schools. This provides a powerful tool for achieving the goals of the UHS project.

Telecommunications Support for Enhanced Communication for Acute Evaluation and Treatment of Vascular Ischemia

This sub-project called for physicians to be able to receive streaming video and audio to their homes for the purpose of patient evaluation in the event of stroke.

UIHC TS researched and installed xDSL lines to the UIHC Emergency Trauma Center and two other locations in Iowa City. We also assisted the sub-project researchers in the testing and acquisition of various supporting video capture equipment and in working with the Macintosh-based teleconferencing system that was developed.

Presentations

As an on-going service to the University community, the department has been active in giving presentations in support of symposiums, conferences, and tours. Members of the department have also been active in supporting or providing instruction, in both formal classroom settings and at conferences. (Attachment 122)

The department hosted visitors from several foreign countries over the course of the NLM II grant. The development of videoconferencing services was shared with a delegation from Hebei province, China (Attachments 123); Suwom, Korea (Attachment 124; Tokyo, Japan; Wales, U.K.; India; as well as places closer to home. Each tour and overview was tailored to the interests or needs of the guest. The experience gained by the department was also shared in instructional venues at conferences and classes. (Attachments 125-126).

Related Activities of UIHC Telecommunications Services

Over the course of the three year project, the level and variety of videoconferencing activity have grown. Where once the service was experimental in nature, it has now been embraced by several

departments as a regular means of disseminating information. Projects that were begun to study whether a service was even possible using interactive video, is now providing regular medical consultations. Distance learning is a given across the academic world. Medical practice is lagging only because of the questions surrounding interstate licensure and reimbursement issues with insurance providers. These barriers are sure to fall in the next couple years.
The department year-end reports are attached for Fiscal years 1998 and 1999. The current fiscal year is seeing increasing activity with regular CME offerings through grand rounds and the College of Medicine, medical consults with the prisons, training and education for staff development, guest speakers, and now legal depositions provided by medical specialists. (Attachments 127-129).

<u>Year 2000 (Y2K) and Implications for NLM telemedicine projects</u>

Nearly all devices currently manufactured today come with some form of steady state electronics or embedded microchip technology to enhance or enable performance. Some of these devices may contain electronics that are incapable of handling the four-digit year 2000. The reason is that as a form of abbreviation the last two digits were employed to describe the current year instead of the standard four-digit convention in both software and hardware systems. The problem occurs when the last two digits roll from 99 to 00. A possibility exists that date dependant functions believe the current year to be 1900 and not 2000. Other potential problems include register over runs, incorrect date stamps causing invalid data and other anomalies undermining the functional integrity of core systems.

Many of today's systems providing core services contain date and time dependant electronics, so the potential scope of this problem is widespread. Consequently, hardware (BIOS, real-time clocks), operating systems, security services, database-management systems, transaction-processing systems, electronic data interchange and banking systems, spreadsheets, telephone systems, and more can be affected by this problem.

In dealing with the Y2K problem, the available options encompass recognition of devices that are not compliant first. Next, non-compliant devices are scrutinized to determine the feasibility of making them compliant. If the feasibility of making a system compliant, taking into consideration time, cost and other factors is good, steps should be taken to do so. Other options may include replacement, rewriting code to accept 4 digit years or rolling the date back (where possible) until a suitable alternative solution can be found.

Due to the high use of microchip based hardware and software technology in all facets of our environment, the scope of the Y2K problem has the potential to be widespread. It therefore becomes essential to establish a plan that gives an approach to recognize and account for suspect systems. This plan should also provide mechanisms for verifying system integrity and identify potential solutions that will be employed in case difficulties arise with these systems.

The first step in defining a scope of impact for the Y2K problem is to identify all systems that are at risk. To define the systems, a thorough inventory must be performed. This inventory should also include secondary services such as infrastructure, power, heating, maintenance and cooling systems that may be relatively transparent, but can have date and time dependencies.

Once all systems viewed as potentially suspect to the Y2K risk have been identified, it then becomes necessary to prioritize them. The prioritization of these units is made based upon their inherent value to the institution and the relative impact of not having services they provide available. When considering the impact of not having certain services available it is also necessary to keep in mind all safety considerations and any secondary effects that may arise as a result.

In order to ensure complete functionality of all core systems, both during and after the Y2K transition, extensive testing is necessary. Processes tested should ideally simulate production services in a test lab environment. This environment will contain the same vendor specified Y2K compliant hardware and software configurations seen in the production environment, and should be placed under the same rigor. To adequately simulate production environments it becomes necessary for individuals trained on the system in question to apply consistent and methodic "real world" scenarios. All testing should be documented, reviewed for anomalies and compared to vendor claims to verify their integrity.

Exception reporting is a mechanism used to identify in greater detail any problems that could occur. Exception reports contain the type of equipment present (name, model number, serial number, function), location, problem description (priority of problem), action plan (responsible party) and the resolution. (Attachments 137 and 138) If an exception occurs, an exception form to assess and address the problem will be completed.

To ensure complete functionality of all service providing systems it is necessary to monitor those systems closely during and after the millennium change. All such devices should be checked and tested initially for date and time progression and correctness. Devices should then be checked for correct function, integrity of services provided, integrity of services received by other systems and functions that may have an impact upon other dependant systems. The initial frequency of these system examinations should be hourly, with the frequency decreasing as confidence in the integrity of the systems increases. The final frequency of system integrity evaluation is expected to be weekly, and may span periods of several months following the millennium change. (Attachments 139 and 140)

An effective contingency plan will encompass an awareness component, an assessment component, a planning component, an implementation component and a testing component. Within the contingency plan the awareness portion will include a definition of the potential problem(s), and will educate individuals as to those problems nature and existence. The awareness of these potential problems will also help to formulate teams and bring about executive support of those methods and mechanisms employed to deal with them. The assessment component of the contingency plan will ideally be used as a method of recognizing relative impact and scope of potential problems. In dealing with potential problems it becomes necessary to implement a planning component that identifies core businesses, inventories and prioritizes systems within those core businesses and establish a year 2000 compliance plan to undertake for these systems. Once these plans have been formulated, it becomes necessary to take implementation steps that would include system conversion, planning or elimination as needed. As a final component of the contingency plan, it then becomes necessary to implement the testing phase by putting those changed systems into functional operation. (Attachment 141)

Y2K Solutions

University of Iowa Hospitals and Clinics Telecommunication Services (UIHC TS) strives to provide uninterrupted data services to its' customers. Y2K considerations therefore have a distinct possibility of making a noted impact on the services that we provide and the NLM sites receive. In response to this, UIHC TS has taken the approach of following vendor recommendations with regards to hardware and software compliance levels, and then thoroughly testing those systems. This way, the vendor statements of product integrity can be validated.

A thorough inventory of all NLM site telecommunications equipment, when compared with vendor specified Y2K compliance requirements found that action needed to be taken. As with all vendors during the 1999 calendar year, numerous telecommunications equipment manufacturers began making Y2K patches and upgrades publicly available on a regular basis. After comparing vendors Y2K minimum software versions to the current versions found in the NLM remote site telecommunications equipment, it was realized that all remote site components needed to be upgraded. Before the telecommunications equipment was upgraded however, the devices in question needed to be tested to verify manufacturer claims of device integrity.

As a requirement to attaining year 2000 compliance as per UIHC TS standards, testing was required. Consequently, one of every device found at each NLM site was placed in a test lab and evaluated in two different manners. The first manner of evaluation required that each unit be checked for correct function and data integrity during transition on the following dates of importance.

9/8/1999 – 9/9/1999
12/31/1999 – 1/1/2000
12/31/2000 – 1/1/2001
2/28/2000 – 2/29/2000 (Leap Year)
2/29/2000 – 3/1/2000 (Leap Year)

The second manner of evaluation focused on time synchronization and correct functionality in the new year. For this evaluation, one of every telecommunication device located at each site was placed in a test lab. Each device was time synchronized with the date set to Friday, December 31. A Network Management Station (NMS) was placed in the test lab and configured to poll each device every second to ensure functionality. The devices were then left to run unimpeded until their clocks reached March of 2000, with random time synchronization checks.

Each NLM remote site contained, at a minimum, a 25xx series Cisco Router, a Cisco or Cabletron Hub and an ADC Kentrox Data Service Unit (DSU). In order to effectively resolve the issue of compliance it would be necessary to determine software levels each vendor specified, upgrade the units, put them in a production configuration in the test bed and then test them thoroughly. The details of the date testing are as follows. (Attachments 142, 143, 144)

A test network employing all UIHC data infrastructure electronics was assembled in the test bed. All electronic equipment in the test bed was setup with the same configuration as the production equipment in the production network.

All electronic equipment was then researched via the World Wide Web for the manufacturer specified Y2K compliant hardware and software versions. All electronic equipment was upgraded to the specified versions.

A Unix based NMS was then built to manage all devices in the test bed. The NMS ran a NMS software application called Netview, that was configured to poll the status of each device in the test bed every second. (In production, our NMS polls for device status every 5 minutes. This unit was configured for maximum sensitivity to any network anomalies that might occur).

Two personal computers were placed in the Y2K test network and configured with the appropriate software to allow file transfers and remote login sessions.

A 66-megabyte file (66371045 bytes) to be used in file transfers between two computers was created.

An application called ID was downloaded. This application uses SHA (Secure Hash Algorithm) to produce a 160-bit "checksum" or "fingerprint" of the file it is run against. This application was then run against the 66-megabyte file created in step 1 to obtain the following checksum:

C05814b3 6a59dabc 917a7da4 f837c37 2dd0e27c

A UNIX script to simulate an active telnet /remote login session (five minutes worth of running commands) was created.

Date Testing

To test a given piece of network equipment two computers were strategically placed on opposite ends of the Y2K test network. This allowed us to test all devices between the computers by performing a data transfer between the computers.

File Transfer Protocol (FTP) server software was installed and activated on computer #1.

From computer #2, a telnet session was created to the UNIX NMS host, spanning the network device to be tested, and the UNIX script was run in real time.

An FTP session was established from computer #2 to computer #1, initiating the download of the 66-megabyte file from one PC to the other.

The network device being tested was then configured to have its date and time roll from September 8, 1999 to September 9, 1999.

During the time and date rollover, the NMS was monitored in case any loss of networking services was encountered. The telnet session was also monitored to see if any lockups or anomalies occurred.

Once the file transfer was complete and the time/date rollover occurred, the checksum computation software was run against the transferred 66-megabyte file. The checksum of the transferred file was then compared to the checksum of the original file to verify the integrity of the data.

The file transfer rate was then documented. (All file transfer rates during the Y2K testing were documented and scrutinized for potential Y2K related bandwidth problems).

The next step was the valid date testing. An FTP and telnet session were started (spanning the network device being tested) and the device had its date changed to the following:
February 29, 2000
February 29, 2004
September 9, 1999
September 10, 1999

As the date changes were occurring, the telnet session running the Unix script and the NMS were monitored closely for any anomalies that might occur.

Once the file transfer was complete and all dates had been changed without incident, the checksum software was run against the 66-megabyte file to verify its integrity.

The file transfer rate was then documented.

The invalid date testing was then performed. The following invalid dates were entered to ensure that the equipment being tested would give an appropriate error for inputting such a date.
February 29, 2002 (Not a Leap Year)
February 29, 1997 (Not a Leap Year)

Steps 1-8 were then run on the same network device for each of the following time/date changes in step 5 above :
December 31, 1999 11:59:00 PM → 12:00:00 AM January 1st, 2000
February 28, 2000 11:59:00 PM → 12:00:00 AM February 29th, 2000
February 29, 2000 11:59:00 PM → 12:00:00 AM March 1st, 2000
December 31, 2000 11:59:00 PM → 12:00:00 AM January 1st, 2001

Time Synchronization Testing

On October 22, 1999, one of every date sensitive piece of network electronics was placed in the test bed. At this time all devices were inventoried for their firmware versions and upgraded if they were not Y2K compliant.

The inventory information is as follows:

DEVICE		Flash/Firmware Version		Y2k Compliant per Vendor Information
Cabletron MMAC (EMME-6)		3.23.01		Y
Cabletron Micro		1.32.01		Y
Cisco 1600 Router		11.1(10) AA		Y
Cisco 1100 FDDI concentrator		3.6		Y
Cisco 7000 Router		11.2(16) P		Y
Cisco 2514 Router		11.2(16) P		Y
Cisco 2518 Router		11.2(16) P		Y
Cisco 7513 Router		11.2(16) P		Y
Cisco Cat 5000		2.4(3)		Y
Cabletron SEHI-34		1.11.02		Y

All of these time/date sensitive pieces of equipment were time/date synchronized with an NMS in the test bed. Due to the need for a control group the NMS was not configured to run in the year 2000 and all pieces of equipment were synchronized to it. All equipment seen above was then configured to Friday, December 31, 1999. The equipment was then allowed to run continuously, with random time synchronization checks until what each device thought was March of 2000. (Attachments 145, 146, 147)

Upon completion of the date testing of all simulated NLM networks, it was determined that equipment upgraded to vendor specified levels would retain complete functionality. Therefore, it was determined that all telecommunication electronics found at each NLM site would need to be upgraded to the vendor specified hardware and software levels. The two month time synchronization testing of all network electronics yielded positive results, reaffirming that the devices in question would retain functionality into March of 2000.

Each Wide Area Network (WAN) site was notified and made aware of the need to upgrade the telecommunications electronics installed at each NLM site. Downtime for these upgrades was coordinated with site contacts and the Telemedicine Resource Center. A technician was dispatched to each site to complete the upgrades or replace equipment that failed the upgrade process. The average time required to complete the upgrades and/or replacements at each site was one hour.

Y2K: The Event

In preparation for the millennium change, UIHC TS implemented a command center within the UIHC, complete with a full complement of staff on-site. (Attachment 148) All services were actively monitored and tested during and after the Y2K occurrence to detect any anomaly or integrity issues. If telecommunications related services were impacted, a Y2K contingency plan with contact information and disaster recovery procedures was available and would have been implemented.

UIHC TS developed a command center that provided a centralized reporting and monitoring location for Y2K related issues and troubles. The command center was equipped with four telephone lines and four Ethernet connections. Backup telephones, cable TV access, voicemail and access to the Emergency Notification System were also available. A WordTrek Paging Terminal was also available to provide alphanumeric paging capabilities to hospital employees equipped with compatible pagers. (Attachment 149) The command center was prepared to handle any data, video, voice or power related outage.

On the night of Y2K, the command center had the following documentation available. Vendor information, exception forms, contingency and disaster recovery plans, Management Station Testing Matrix, Network Electronics Monitoring Checklist and UIHC TS employee contact information. (Attachments 150, 151, 152, 141, 148)

In case of a disaster, Telecommunications Services would continue to provide communications services to the best of their ability. In the unlikely event service was adversely affected, we would prioritize our restoration efforts (staffing, hardware and other support systems) based on the criticality of the patient care areas in the UIHC. (Attachment 153) Telecommunications Services contingency plans included a complete inventory of our equipment, location of hot spares, exception forms and schedules and duties of UIHC TS employees. (Attachments 151, 152, 141, 154)

Every telecommunications network device under the auspices of UIHC TS was tested immediately after the year 2000 transition. Network devices were monitored twice every five minutes using two NMS workstations. Manual testing of all networking devices integrity continued throughout the Y2K weekend and into the following week. Frequency of this testing decreased only as confidence in the integrity of the tested systems increased. Continual manual testing was performed during the month of January on all telecommunications network devices. (Attachment 155)

While UIHC TS makes every attempt to provide uninterrupted service, access to the UIHC may require external resources beyond our control. Resources such as the Iowa Communications Network (ICN) and vendors such as US West and GTE are external to the UIHC, but are vital to the services we provide to the NLM WAN sites. In consideration of this fact, UIHC TS had a fiber phone in their Y2K Command Center. The fiber phone provided a direct connection to the State Emergency Operations Center in Johnston, Iowa. In addition, contact information for every vendor was readily available in the Y2K Command Center.

UIHC TS and their customers experienced no loss of service either directly or indirectly as a result of the millennium change. All UIHC TS provided services experienced no degradation in their levels of integrity or performance during the transition and into the Year 2000.

Lessons Learned

Staffing

How many Telecommunications staff members are required to support 10 remote sites? What training should they have? Sending UI Staff to remote sites for installation or maintenance means these individuals are not available for other types of services required at the hub site. In addition, technicians might have to spend an entire day traveling to do a job that might only take an hour or two. What happens if your staff is at a remote site resolving a problem when another problem is encountered at the hub site or another remote site? How are priorities determined? Recruiting and retaining qualified technical staff is difficult, particularly in times of a tight labor market or uncertainty about the future of telemedicine projects.

Tools of the Trade

When an organization begins to support remote users, they need to make sure they have the tools in place to quickly and efficiently do installations and provide ongoing monitoring. For example, fiber optic tools such as a fusion splicer, light meters and an optical time domain reflectometer. Additional useful equipment includes copper cable installation and testing tools. Another important strategy includes establishing redundant SNMP network management system. An institution beginning an outreach program would have to make an investment in these items.

Product and vendor standardization becomes extremely important when supporting remote sites. Trying to support a multitude of vendors and products is extremely difficult for the average technician. By standardizing on certain products, the technician can develop a better knowledge base of the product. This reduces installation time significantly and streamlines problem resolution efforts. Standardization also significantly reduces the cost of a spare parts pool as well as reduces training time. The downside of standardization is that you lose the flexibility of providing a custom solution. However, in those instances when an exception to the standard offering is required, options can be evaluated with the same forethought given to the initial product selection.

The issue of buying or not buying a maintenance contract is an issue that many institutions struggle with. Organizations that self-insure themselves reduce their cost, but leave themselves at the mercy of the vendor at the time of a problem. We felt that since we were supporting healthcare organizations that we should try to ensure the shortest downtime when an outage occurs. Our current policy is to purchase 7 x 24 phone support and 24 hour parts replacement from vendors of high-ticket items. When an outage occurs, having the proper diagnostic tools and the availability of phone support allows us to quickly determine the cause of the problem. We then take the appropriate hot-standby spare from our spare parts pool, and taking one of the vans mentioned above, can have the outage resolved within several hours. In these situations, the vendors will ship a replacement to us via overnight courier. The replacement then goes into our spare parts pool and becomes a hot standby.

Remote Site Issues

Rural hospitals often have limited in-house networking or telecommunications experience, which makes on-site coordination more challenging. This problem was most common at the smaller rural hospitals. The larger the hospital and the community, the more likely this local experience would exist. If a technical person existed, they often had many diverse responsibilities and no backup. Identifying and training key contact people at each remote location helped overcome these problems.

Many of the community hospitals in our network suffered from a lack of dedicated space, or any space at all, for telecommunications equipment placement. This resulted in creativity in telecommunications equipment placement. Often the equipment was placed in a shared area such as a storage room, closet, computer room, and office or above the ceiling. From this main location, wiring was then run to each workstation location. If this location was not centrally located, excessive (over distance) workstation runs were the result.

Individual requirements for convenient workstation locations changed frequently. This often came about as rural staff members realized they had a need to "reclaim" an existing space, plan for a remodeling project or just move the computer to a spot where it would be better utilized. In these instances, additional workstation wiring would need to be run. Because of the distance and time involved in traveling to and from these remote sites, it often meant that technicians required an entire day to install one or two cables.

Of the ten telemedicine sites, only one had a sufficient internal telecommunications infrastructure (wiring) to support the network being installed. Thus, a substantial amount of re-cabling was necessary. We learned that most rural hospitals will need to upgrade their infrastructure to support networking and telemedicine, although this can probably be said of many urban hospital environments as well.

Most rural hospitals had extremely old wiring not capable of reliably transporting today's high-speed data applications. This wiring was primarily used to support local telephone systems. In some instances, additional wiring existed to support terminals on legacy systems such as mini-computer based hospital information systems. Consequently, none of this wiring could be used and all new wiring had to be run to support the NLM project.

Additionally, many rural hospitals did not have adequate lightning protection where the copper provided by the local Telephone Company enters their facilities.

For redundancy and disaster management, we initially planned for a low speed switched 56 kbps link or a 56 kbps Frame Relay link for a backup WAN connection. This would have been utilized in the event that the primary WAN connection failed. After using these redundant circuits for several months at non-NLM sites, we reassessed their usefulness and decided not to use them for financial reasons, since they were not cost-effective.

We struggled with the issue of rural hospitals wanting to buy their own workstations and attach them to the NLM network for Internet access. Additionally, some of the hospitals fortunate to have their own internal LAN also wanted to connect their network to the NLM network for the same reason. We were unable to fulfill either of these requests. Although these requests were technically feasible, they were not possible due to the following operational and policy related concerns:

Who would be responsible for installing, supporting, maintaining and troubleshooting these remote devices? Problem resolution becomes difficult as issues need to be addressed such as: is this a network problem or a workstation problem?

Can the University legally provide Internet Service Provider (ISP) type services to non-University entities? The University is expressly forbidden to offer ISP type services to non-university affiliates by legal statute and existing non-compete contracts with MCI who currently provides these services to the University. This would be possible, if the University owns the remote network (workstations, LAN and WAN equipment and cabling) and or the other entity is a legal business affiliate of the University.

Providing for reliable power is often overlooked in system installations. Particular care needs to be taken at remote sites where others may have access to your power. We have had several situations where people will plug their own equipment into your UPS, potentially oversubscribing it. Also we've experienced situations where people will turn off your UPS and subsequently down your equipment. SNMP monitoring is an effective tool to provide notifications that your equipment is being tampered with. Also simple labels on UPS with contact information with mention of who is authorized to use, provides a degree of protection.

Carrier Issues

Long Distance providers and local telephone companies have been transitioning, downsizing, and re-engineering for the past several years. This activity has caused telecommunications managers to take much more responsibility for the supervision and oversight of these companies activities in the installation process. Thus, the amount of time needed for this supervision is substantial, and the amount of "buffer" time planned into installation schedules has increased steadily over the years.

A "normal" amount of time was allocated to the installation process for the NLM circuits (based on experience with a number of long distance carriers/local telephone companies as well as the ICN). However, we were somewhat unprepared for the amount of time required to supervise the ICN installation process and ensure quality control.

The local telephone companies provided the local connectivity, or loop, for the NLM circuits. In dealing with various institutions and businesses, these local telephone companies generally install cable adequate for the current needs of the institution, as well as additional service for growth. Apparently, due to the low amount of growth in local telephone service needs in rural communities, the local telephone companies and the institutions fill these cables near or to capacity. This problem is further compounded by the fact that Iowa has almost 150 independent local telephone companies.

When orders for circuits such as for the NLM are placed, no local service is available, and circuit installation must be delayed until the local Telephone Company can install additional cable. Normal procedure is such that the long distance carrier order process is well underway before this information is discussed between them and the local Telephone Company. We have learned that we must insist on not only database verification of available cable pairs but on-site verification of available cable pairs by the local telephone company early in the ordering process to avoid unnecessary delays.

Iowa has the largest number of independent telephone companies of any state in the county with 149 Local Exchange Carriers (LEC). Some of these LECs are quite large, such as US West and GTE, which cover large non-contiguous areas. However, the majority are quite small, serving a county or given township within a county. In addition to all of the LECs, Iowa has 6 Local Area and Transport Areas (LATAs) of which the United States has 161 total. LATAs are geographical areas (i.e. intraLATA) in which LECs are able to offer local and long distance service. However, they are prohibited from providing these services between LATAs (i.e. interLATA) even if they have a presence in both. Inter Exchange Carriers (IXCs) such as AT&T, Sprint and MCI provide these interLATA services. The Iowa Communication Network also provides these services to state owned entities.

Coordinating the installation, maintenance and troubleshooting of WAN circuits with this multitude of LECs and IXCs is a daunting task. The WAN services installed for the 10 NLM and GSA sites had to run from Iowa City to two other LATAs and a total of 5 different LECs. See (Attachment 156) for specific details on the NLM Testbed LECs and LATAs.

In Iowa, we are mandated by statute to utilize the Iowa Communication Network whenever possible. All orders for services were placed with the ICN who then coordinated the installation with the appropriate LEC(s). As mentioned earlier, we then had to follow-up with the ICN and the LECs to make sure they completed the job on time and as ordered.

Example:

A Typical T1 connection, such as to Keosauqua, would be linked as follows:

- The initial order for service would be placed with the ICN. Assuming that appropriate carrier infrastructure was in place, the order would usually be filled within one month.
- In Iowa City, A tail circuit would be ordered from US West and extended by them from the University Hospital to the nearest ICN point of presence (POP).
- At the Iowa City ICN POP, the circuit would be routed to the ICN main hub at Camp Dodge in Des Moines.
- In Keosauqua, a tail circuit would be ordered from the Van Buren Telephone Company, who would extend it from the Van Buren County Hospital to the nearest ICN POP.

- At the ICN POP in Keosauqua, the circuit would then be routed to the ICN main Hub at Camp Dodge.
- These two circuits at the ICN would then be cross connected together to form a complete circuit.
- The ICN would then initiate end-to-end testing before turning the circuit over to the NLM Telecommunications Services staff.
- (Attachment 157) is a diagram that graphically depicts the connectivity between the LECs and the IXC (the ICN in this case)

ISDN Video

Although ISDN has been available for a long time for inter-carrier connections, it is still in its infancy for video conferencing. There are different national and international ISDN implementations (dialable wideband Vs bonding, 24-channel vs 30 channel, PRI vs BRI etc). In order for a valid connection to occur everyone must be speaking the same language. Additionally, vendors have their own proprietary "standards" that can cause interoperability problems with other vendors' products if not configured properly.

We cannot stress enough the importance of pre-testing ISDN connections with remote sites before scheduled events. For those videoconferences involving multiple sites, this also involves scheduling and testing with the required Multi-Channel Unit (MCU) or bridge for point-to-point conferences. The issues become even more difficult when you deal with the integration of BRI and PRI utilizing multiple local and long distance carriers both locally, state-wide, nationally and internationally, not to mention time zone, cultural and national language differences.

Planning Issues

The vast majority of the NLM sub-projects required the use of the Internet Protocol (IP) networking protocol. Many issues were raised and resolved in the early stages. Listed below are some of the issues dealt with and solutions

One of the first issues that came up dealt with name space liability and ownership (e.g. "uiowa.edu"). Along with this came the problem of "ownership", assignment of subnet identifiers and domain and sub-domain names to each of the remote sites. Additionally, host machine naming conventions had to be developed.

We were faced with the need to preserve IP subnets. Typically, two subnet addresses are required for each remote site; one for the WAN connection and one for the remote LAN. Ten remote sites would require 20 subnet addresses. Under our addressing scheme this would normally support over 5,000 users. Supplying 20 subnets would be a waste of limited resources.

Decisions regarding Internet access to remote sites other than NLM required resources (being an ISP) needed to be made. In other words, could an authorized user jump from the Virtual Hospital web site to the Wall Street Journal web site?

Issues of support and liability. There were requirements for referring healthcare providers to access secure patient data from the UIHC INFORMM system. How would this be handled in a secure way?

Solutions

Decisions were made to allow remote sites to utilize the uiowa.edu domain and radiology sub-domain. Host addresses would consist of the site name followed by a number assigned to that workstation. An example of a complete workstation host name is: ottumwa5.radiology.uiowa.edu.

Variable length subnet masking was utilized to preserve IP addresses. 255.255.255.224 was used as a subnet mask at remote sites. This allowed for up to eight remote sites per subnet and up to 30 host addresses for workstations. At each remote site a subnet mask of 255.255.255.248 was used for the WAN connection. This allowed for up to 36 serial WAN connections per subnet and up to seven host addresses per serial connection for routers and DSUs.

Attempts at restricting Internet access by utilizing router access lists were highly effective, but due to Virtual Hospital links to other non-University of Iowa sites they were removed. For example, the Virtual Hospital might be linked to the Mayo Clinic Health Book necessitating "open" access.

INFORMM access was provided using Security Dynamics "Secure-ID" card, which relies on secure token passing and authentication. Authorized users at remote sites were given Secure ID cards and proper training.

Keep it Simple

Users want "plug & play" solutions. However, in each aspect of this type of installation, there are numerous options depending on the types of information services to be offered, the speed at which these information services must be delivered through the network, the availability of technology to deliver the services, the price for the service at the desired level of quality and various other issues.

It is critical to obtain this information so the best options for the particular installation can be selected. However, the complexity of the issues and the great number of options are a bit overwhelming to many users. Thus, a method must be found to reduce the complexity as much as possible.

Such a method might be in the creation of an information services matrix. This matrix (which is currently under re-development) provides a list of information services with categories noting bandwidth/connectivity requirements, hardware and internal networking requirements, as well as cost ranges. Users, even those with no telecommunications or computer/networking knowledge, should be able to select their basic network requirements and identify the estimated cost, based on the types of information services desired.

Future Planning

Once the users have provided the above information, UIHC TS staff will design the network, selecting specific components (and numerous options within the components) to properly configure the network, addressing current and future needs of the users. Although vendors are addressing this issue, we have learned that some networking hardware does not promote simple or inexpensive migration from lesser services and connectivity to more robust network services and connectivity. An increasing number of manufacturers are considering this in their newer product lines, which should make enhancements and upgrades easier and less expensive.

Due to the desire for increased access to health care information services, once these services are introduced, requests for greater and more widespread access generally follows soon after. This is actually a healthy phenomenon, as it substantiates the original premise and it encourages the staff to utilize the network and services.

UIHC TS purchased a digital camera for remote site documentation. The camera has proven to be an invaluable tool. The digital pictures have allowed us to better document remote sites and to mount the images on our web site. This graphically presented information is valuable for the network planner and the technician alike, and can be utilized in diverse events ranging from facility planning to problem resolution.

Many of the challenges of this project related to technology. An optimum platform was central to the implementation of this project. Expectations were quite high about the emergence of a system that was:

Easy to use - able to be brought home and installed by laypersons
Reliable - systems that can be maintained by non-computer users
Expandable - able to accommodate latest browser capabilities in a quickly changing market
Powerful - able to accommodate multi-megabit streaming video

With reassurances from major vendors such as Sun, IBM, and Oracle, our early concerns regarded selecting which product that would emerge as an industry standard. These concerns turned quickly turned to finding *any* product that would satisfy our needs. This class of product never materialized. However, a Network Computer did appear. Improved ease of use, decreased costs in PCs caused by commoditization of components, and PC Manufacturer's focus on the home market resulted in the PC becoming the Network Computer.

Lessons to be learned from the experience:

- Minimize your technology dependence - allow alternate avenues of delivery. Keep education the focus, not technology.
- Do platform trials early - This will help you determine an acceptable platform.
- Be flexible - We didn't recognize that the PC had become the network computer until later in the project because we were expecting a small form factor system.

In the evaluation of remote access servers, we were tempted to use a newer product by 3Com that promised better performance and easier administration. However, by deploying a piece of hardware that we had experience with, we were able to meet a tight deadline, provide high reliability, and reduce costs. When we had to expand its logging facility, off-the-shelf-solutions were available. Lesson learned: use older, tested technologies when available.

At the onset of the project there were few streaming video vendors. Solutions were proprietary and costs were high. By the end of the project many more had appeared and standards had emerged. Most notably Apple computer is providing a product called Apple Quicktime Streaming Server that provides many of the features of SGI's Mediabase at a fraction of the cost. Additionally Apple has open sourced this software so it is available on no cost operating systems like Free BSD and Linux. It's now possible to build a streaming server with many of the features of SGI's Mediabase for less than $2500. Dramatic cost reductions due to technology are common enough that they are now featured in TV ads. In our case, because of our inability to know how long deployment would take, the technology and timing deployed for the project was appropriate.

However, it does introduce the notion of considering appropriate timing in your technology rollout. An article "The Effects of Moore's Law and Slacking on Large Computations" calculates an optimal time for technology commitment given performance objectives, Moore's law, and a set budget. (http://arxiv.org/abs/astro-ph/9912202). This article focuses on brute computations as the performance objective but it is simple to see how the principle of appropriate rollout timing can apply to streaming video and other technology dependent endeavors.

Lesson learned: Determining when you should deploy a system is complicated by uncertainty as to how long system will actually take. However, by considering appropriate rollout times based on advancements in technology, you can minimize cost and maximize performance.

As we discovered in our y2k preparations, guarantees regarding software revision level required for y2k compliance were continually changed up until December 31st without notifying customers. It was important to recognize that vendors may have been more concerned with shielding themselves from liability than providing optimal service to their customers. By acknowledging that we may not be able to apply all late breaking patches, identifying our most critical systems, and doing extensive in-house testing of our equipment, we protected our quality of service interests and shielded ourselves from reliance on vendors. In short, be aware of vendor's motivations, and don't allow trust in a vendor to put yourself in a compromised position – always give yourself a contingency plan.

Technology in General

Rapid changes in the information processing and transmission fields caused several initial solutions to projects to become obsolete prior to rolling the project into the test field. At other times, the reliance on vendor promises to supply products within a given timeframe proved to be disappointing. What worked best was building a relationship with certain vendors and requiring a high level of communication during the process of testing, implementation, and on-going troubleshooting.

This communication also carried over into vendor to vendor cooperation when incompatibility issues arose between components in an integrated system. NEC supplied a video codec to Ascend for dialing protocol issues. NEC also worked with ADC/Kentrox in codec to ATM concentrator issues.

Supporting videoconferencing at remote sites was simplified through standardization of the equipment installed. When an issue arose, troubleshooting could be handled by referring to standard configuration lists. Reference materials could be prepared and distributed to all users. Software upgrades could be purchased in quantity at cost savings.

As a telecommunication department, it is important to interview the person or department requesting a new service to determine the following issues: What needs to be transmitted and received; Where will the transmissions need to go; How is the transmission to be used, stored, interpreted at each end; Is the transmission one-way, two-way asymmetrical, or two-way symmetrical; and what is the future trend for this activity? By answering these questions, the pool of possible solutions is diminished.

As an example, by applying this earlier in the pediatric cardiology project, we could have saved time spent researching the store-and-forward avenue. The typical echocardiogram for an adult is 2-5 minutes in length, making the resulting digital file a manageable size. It was later found that the typical pediatric echocardiogram is 15-25 minutes in length. The resulting files would have consumed the largest hard drives at the time and would have taken over half an hour to transmit over the fastest T-1 circuits that we could have provided. It was also found that technician to technician interaction enhanced the quality of future studies, performing an ad-hoc training activity.

Staffing

Finding the right balance of staff members to remote sites can prove complex. One strategy that proved helpful was to cross-train staff and to communicate each staff member's activities to the rest of the staff. This was maintained through weekly staff meetings, the use of Microsoft Team Manager, notification of upcoming activities through e-mail broadcasts, and extensive use of Microsoft Outlook shared calendars. The cross training allowed each staff member to have a back-up to assist when he/she was working at a remote site and the calendars allowed for joint scheduling of absences.

As anywhere else, small, rural hospitals and health centers experience staff turnover. In the case of small hospitals, the turnover of one staff member may literally wipe out a department. The replacement may or may not receive a briefing from the outgoing person. In the case of complex telecommunication services, the briefing may not adequate.

Training and refresher training became semi-annual events for most of the remote sites supported by Telecommunications Services. Several of these were conducted through a scheduled videoconferencing session. Other times, the introductions and refresher training for new staff at a remote site preceded a previously scheduled medical consult or Grand Rounds session, or in the course of testing for these other events.

Maintenance

Hospitals are the original 7x24 service providers. As such, a critical service cannot be down for an extended period of time. An adequate supply of replacement parts has been maintained to meet this demand for service support. In the case of inverse-multiplexers and codecs, these devices can be pre-configured for the remote sites due to the previously mentioned standardization policy. Troubleshooting guidelines have been prepared for NEC-based codec systems located at remote sites. These allow the remote user to narrow down a problem and, in many cases, find a solution without calling for remote support.

Summary

UIHC Telecommunication Services is honored to have played a major role in the deployment of the rural telemedicine LAN and WAN testbed. The combination of staff skills and experience, past successful project deployment and knowledge of the healthcare industry and its unique requirements puts us in an enviable position that will ensure our continued success.

Conclusion

The National Library of Medicine Contracts at the University of Iowa have been a multifaceted endeavor involving a number of departments from the University of Iowa and the UIHC. In what can only be described as a team effort, these departments joined forces to conceptualize, visualize, plan, and implement a telemedicine network. This network extended to rural health care facilities a number of individual research projects, a variety of health care information services and clinical programs.

From the initial grant proposal phase of the NLM I Project to the implementation and ongoing operational phase and ultimately the NLM II Project, the Telecommunications Services Department at the UIHC has been an integral part of this endeavor and much has been learned in the process. This information has been utilized in the ongoing operation of the NLM telemedicine network as well as with outreach and telemedicine endeavors at the UIHC and the University of Iowa.

Patient-Centered Multimedia Education for Individuals with Diabetes Mellitus: A Model for Chronic Disease Self-Management.

William Sivitz, M.D. and Vicki Kraus, RN, Project Directors; Bryan Sheeley, Production Coordinator, Web Development and User Support (replacing Greg Easley); Tom Bullers,

Technical Coordinator, Video Streaming, and User Support; Jerry Gilmere, Training and User Support

Our Objectives

The objectives outlined in our 1996 proposal focused on computer-assisted instruction (CAI) and its potential as a cost effective way to help diabetes patients in rural Iowa better understand and subsequently manage their disease. The evaluation plan called for the recruitment of 100 subjects with diabetes who would be randomized and divided into two groups. Group 1 would receive computer-assisted instruction in diabetes for three months while Group 2 would receive traditional, established methods of diabetes education. After three months, the groups would exchange roles, or crossover.

Entrance criteria required the presence of diabetes mellitus for a minimum of a year, a willingness and ability to use computer-assisted instruction, and that the subject be 18-years of age or older. Excluded from the study were patients with other medical or psychological disorders that limited their ability to use CAI, pregnancy or planned pregnancy during the course of the study, and social or economic problems limiting ability or time to use CAI.

Our Approach

Clinical trials like the Diabetes Control and Complications Trial (DCCT) demonstrated that keeping blood sugar levels as close to normal as possible slows the onset of complications caused by diabetes. Well-educated individuals with diabetes are better equipped to manage their disease. At the time, studies suggested that computer-assisted instruction was a cost-effective way to help patients understand how to meet goals in the areas of blood glucose monitoring, nutrition, hypoglycemia, and foot care. The hypothesis was that technology had the potential to provide patients an opportunity to actively participate in their diabetes education and have more control over the experience.

Emerging technologies provided many new options to support our approach. New hardware and software developments were making it easier to deliver computer-based education materials comprised of sound, video, animation, and interactivity. However, finding the right combination of hardware and software would prove to be one of the most difficult decisions we would face.

Our stated strategy was to examine patient education opportunities in two ways. In the hospital setting, we proposed the implementation of networked devices connected to a central video fileserver. As a result we developed "Cineplex" to deliver broadcast quality patient education video on diabetes and related conditions. (An example of a Cineplex application for Diabetes patient education is available in Volume IV. In this video, The Diabetes team videotaped a patient support group encounter that will be made available via the Cineplex to Diabetes patients. As part of the patient education experience, "Cineplex" has been defined as a way 'to put a human face' on the diagnosis and treatment of this disease. This video is one of many that is being made available on "Cineplex." For a more technical description of the Cineplex delivery strategy, please see Volume II, Telecommunications/Cineplex.)

In the home setting, our research focused on powerful yet simple devices that would serve as a home multimedia player capable of connecting to the Internet and CD-ROM playback. Many alternatives were researched, demonstrated, and tested. Selecting the right device proved to be the biggest challenge and in the end led to a comparison study of two technology platforms.

Content Development

Our proposal called for the development of content dealing with the fundamental issues of diabetes, its complications, and how the disease can best be managed. Special emphasis was given to the introduction of interactive materials and multimedia in an effort to optimize the learning experience for the end user. Existing diabetes patient education materials served as the infrastructure. The following multimedia capabilities were considered:

- Digital video
- Animation
- Interactive lessons
- Role playing scenarios
- Patient education videos
- E-mail
- User forums
- Electronic testing and performance tracking
- Interactive tools for helping the patient track and monitor blood glucose levels and intelligently plan meals

While the central focus of the project is educating patients, we recognized the potential use of the video fileserver technology ("Cineplex") to deliver continuing medical education video to health care providers in community hospitals. This technology could also serve to deliver on-demand rebroadcasts of relevant Grand Rounds and seminars captured in the university's video classrooms.

The Solution

Designing a solution that would accommodate both the in-home and in-hospital setting started with research on available technology that would meet the requirements outlined in the proposal. Early in the contract several options were being touted as "set top" devices designed for the consumer. Our solution required a device capable of CD-ROM playback and MPEG decoding for video playback. It also had to be equipped with a modem to connect to the Internet and have the ability to connect to a printer. Ideally one device would work for both the hospital and home environments. Special consideration had to be given when choosing a device for the hospital environment because of compatibility issues with video fileserver technology.

Initially, three devices were considered. WebTV from Philips/Magnavox touted itself as an easy-to-use alternative to the computer for easy access to the Internet. Our first look at the WebTV device found it to be rather limited in media support and peripheral connectivity. The WebTV browser also lacked support for Java, Javascript, and video playback, as well as other industry standard web formats. Technical support was also a concern.

The Pippin@World machine showed promise due to its Internet and CD-ROM features, and reports on the second generation of the device were even more encouraging. Shortly after shipping of the product began in December 1996, a unit was purchased for testing. Apple Computer, Inc., was co-developer of the Pippin which it later sold to the Bandai Digital Entertainment Group.

The third device was the Acorn NetStation. The NetStation was marketed as a revolutionary Network Computer designed specifically to work over a network to access information on the Internet. It incorporated a browser, email, and word processing. Acorn believed that network computing would make information, entertainment, education and communication services highly accessible for a much wider audience at a significantly lower cost over a conventional PC. The NetStation included ports for a keyboard, mouse and printer. The Acorn NetStation did not offer video support or a CD-ROM.

We selected the Pippin because it offered all of the features we required and had distinct advantages over the other two. However, before we could implement the devices in our development, Bandai abandoned the Pippin and folded the Digital Entertainment Group due to poor sales. We were fortunate in avoiding any investment in the technology, but at the same time hindered by having to choose between two remaining devices that we considered lacking for our purposes.

Subsequently we selected the WebTV as the device for the home setting and the Acorn STB2 as the device for the hospital setting due to its new compatibility with our selection of the Origin 200 server and MediaBase software from Silicon Graphics, Inc. (SGI). It was not until SGI shipped version three of the MediaBase player that we recognized we would be able to use existing desktop technology to play back the MPEG video stream. This was significant for two reasons. It did not require the purchase of a specialized device for the hospital setting, and it allowed us to consider additional technology for the home setting. Resources that would have been used to fund the purchase of hospital devices were instead targeted for the purchase of a new computer for the in home setting: the iMac from Apple Computer, Inc.

Platform Comparison Study

Before we would commit to either platform, we decided to conduct a comparison study to investigate further usability, features, functionality, and user preferences for the iMac and the WebTV platforms. One issue that immediately presented itself was: how would patients interact with computers and computer-like technology? We recognized that for rural patients who may have limited exposure to computing, the learning curve might be steep. We determined that in order for such patients to make effective use of the diabetes program, they could not be intimidated or stymied by the complex manipulations of mouse, menu, and cursor-driven applications. At the same time, selecting a simple device generally equates with less functionality and interactivity, and fewer capabilities. We didn't want to limit the format and quality of the content, nor did we want to inhibit or obstruct the creation of attractive, engaging, and even fun educational experiences for patients. It became an important issue, therefore, to balance the functionality of the hardware with ease of use.

To find out how the average person (i.e., a non-computer specialist) interacted with these machines, we engaged the services of some 50 volunteers over a four-day period (August 30-September 2, 1999) to try their hand at using both the iMac and the WebTV in a comparison study.

Method

Participant Selection
A total of 50 study subjects were recruited from the University of Iowa Hospitals and Clinics Volunteer Office. We selected this group to approximate a community-based population of non-healthcare providers and non-computer experts. All subjects voluntarily participated in the study, were given an explanation of the study and what they would be doing, and signed informed consent forms (which indicated that participants could withdraw from the study at any time). Because the study design called for each subject to use both platforms, we randomly assigned half of the subjects to begin with the Web TV platform and the other half to begin with the iMac platform. This randomization was done to control for a potential response bias resulting from the order in which the platforms were presented.

Study Design

The first step in the comparison study was to develop a comparison matrix (attachment 1) identifying the features and tools of each platform. Based upon the comparison matrix, task lists (attachments 2a and 2b) were created and performed by volunteers on both platforms. A set of tasks designed around searching for specific educational materials on the Internet were identified. These included Searching, Navigating Back, Navigating by Typing, Navigating within a Website, Scrolling up and down, and opening and replying to an email. To perform these tasks, web pages were established with identical materials that could be accessed by both the Web TV and iMac platforms. Two WebTVs and two iMacs were set up in the Telemedicine Resource Center (TRC) and each participant was accompanied by an observer, who would answer any questions that might arise, and score the individual's ability to perform the tasks. Observers were also given an introductory script created to prevent any appearance of platform preference (Attachment 3). The volunteer was then given 15 minutes to complete the tasks on each platform after which they were asked to rate their experience in terms of ease or difficulty of each task. After each volunteer had completed the exercise on both platforms, they answered questions designed to measure their overall impression of each platform (Attachment 4).

Statistical Analysis

We tested the null hypothesis that there was no difference in overall preferences. ($H_0 : P_{WebTV} = P_{iMac}$). The two platforms were compared for user preference by the chi-square test for all discrete variables. The Fisher Exact test was applied to test the homogeneity that was used in the analyses to determine if there was a bias introduced because of the order in which the platforms were presented. Ninety-five percent confidence intervals were used to compare all major outcomes between the two platforms. Statistical significance was determined using the 0.05 p-value level.

Results:

A total of 50 volunteers were enrolled in 4 days of study from August 30, 1999, through September 2,1999. Baseline characteristics of all participants are presented in Table 1. Despite various degrees of experience using computers, 45 of the participants finished the tasks for each platform within the 15-minute time limit. The remaining five subjects completed the tasks in 20 minutes. For all five in this group, this was the first time they had been exposed to a computer. This group of five included three individuals who began on the iMac and two who had begun the study on the Web TV platform. The one task which each of them failed to do in the 15 minute time limit was to open and reply to an email. These five were excluded from the analysis of this item in subsequent analyses.

Except for slow connections during the peak time (10:00 AM to 2:00 PM), minimal difficulties were found in evaluating the tasks performed. Another technical complexity for some of the participants was using the mouse on the iMac.

Overall, and even for the first time computer users, subjects generally found both platforms easy to operate. Subjects reported finding participation in the study to be challenging, fun, and some of them indicated they were excited about participating and completing the study.

Table 1 summarizes the demographic characteristics for all study subjects combined as well as for the groups randomized to begin either on the Web TV or iMac platforms. Thirty-six percent of the participants were 61-70 years of age, 32 percent were male and 82 percent wore glasses. Over 83 percent had previous exposure to a computer and 92 percent of the study subjects reported being either *somewhat* or *very comfortable* in using a computer. As evidenced in Table 1, the demographic characteristics of those beginning on the Web TV platform were very similar to those beginning on the iMac platform.

Table 1. Characteristics of The Participants

	WebTV starter		**iMac starter**		**Total**	
Characteristics	Number	%	**Number**	**%**	**Number**	**%**
Age						
< 40	6	24.0	5	20.0	11	22.0
41 - 50	5	20.0	5	20.0	10	20.0
51 - 60	2	8.0	4	16.0	6	12.0
61 - 70	9	36.0	9	36.0	18	36.0
>70	3	12.0	2	8.0	5	10.0
Sex						
Female	19	76.0	15	60.0	34	68.0
Male	6	24.0	10	40.0	16	32.0
Use of Glasses/ contacts						
Yes	22	88.0	19	76.0	41	82.0
No	3	12.0	6	24.0	9	18.0
Frequency of using computer						
Never	4	16.7	4	16.0	8	16.3
<5 times/mo	1	4.0	3	12.0	4	8.2
6-10 times/mo	3	12.0	0	0.0	3	6.1
>10 times/mo	16	64.0	18	72.0	34	69.4
Frequency of going out onto internet						
Never	9	36.0	5	20.0	14	28.0
<5 times/mo	1	4.0	0	0.0	1	2.0
6-10 times/mo	5	20.0	3	12.0	8	16.0
>10 times/mo	10	40.0	17	68.0	27	54.0
Type of computer used						
PC comp	12	48.0	14	56.0	26	52.0
Macintosh	4	16.0	2	8.0	6	12.0
Do not know	1	4.0	1	4.0	2	4.0
Do not regularly use	5	20.0	5	20.0	10	20.0
Both PC & Mac	2	8.0	3	12.0	5	10.0
How comfortable using the computer						
Not comfortable	3	12.0	1	4.0	4	8.0
somewhat	11	44.0	7	28.0	18	36.0
very	11	44.0	17	68.0	28	56.0

To further address the question of whether a bias was introduced by the order in which the platforms were presented, we analyzed whether there were statistically significant differences in preferences related to the order of platform presentation. Tables 2a and 2b show that the order in which the two platforms were used did not bias the subsequent comparison of the iMac and WebTV platforms. For all the tasks and items evaluated, there was no statistically significant differences in the patterns of responses between the group which began with the iMac, versus those who began with the WebTV platform. (The Fisher Exact test, $P>0.05$).

Tables 2a and b. Comparison Between Subjects First Using WebTV and Those First Using the iMac Platform: Performance of Task, Comparison of Onscreen Presentation

Table 2a. Comparison in performing the tasks

Category	WebTV First	IMac First	*P value*
Searching			0.4099
Prefer WebTV	9	5	
Prefer iMac	13	14	
No Preference	3	6	
Navigating back			0.6901
Prefer WebTV	8	8	
Prefer iMac	12	11	
No Preference	5	6	
Navigating by typing			1
Prefer WebTV	8	7	
Prefer iMac	10	10	
No Preference	7	8	
Navigating within a website			0.0887
Prefer WebTV	9	7	
Prefer iMac	14	11	
No Preference	1	7	
Scrolling up & down			0.5878
Prefer WebTV	7	7	
Prefer iMac	13	10	
No Preference	5	8	
Open & reply to email			0.8622
Prefer WebTV	10	11	
Prefer iMac	12	10	
No Preference	1	1	

Table 2b. Comparison in onscreen presentation

Category	WebTV First	iMac First	*P value*
Print size			0.3922
Prefer WebTV	10	6	
Prefer iMac	11	16	
No Preference	4	3	
Print clarity			0.1182
Prefer WebTV	7	3	
Prefer iMac	14	21	
No Preference	4	1	
Clarity of pictures			0.4886
Prefer WebTV	4	3	
Prefer iMac	15	19	
No Preference	6	3	
Clarity of images			0.1265
Prefer WebTV	4	3	
Prefer iMac	13	20	
No Preference	7	2	
Screen color			0.1909
Prefer WebTV	7	2	
Prefer iMac	12	16	
No Preference	6	7	
Screen brightness			0.1902
Prefer WebTV	7	2	
Prefer iMac	16	16	
No Preference	4	7	

Based on these results, we then analyzed the overall sample for differences in preferences for the WebTV versus iMac platform. Because subjects could indicate a preference for one of the platforms or no preference, the analysis included only those responses indicating a preference for one or the other of the platforms. Tables 3a and 3b summarize these findings. For the specific tasks subjects were required to perform, there were no statistically significant differences in the preference for the Web TV versus the iMac platform for any of the tasks with the exception of Searching (Table 3a). That is, for most of the tasks performed (navigating back, navigating by typing, navigating within the Website, scrolling up and down, and open & reply to email) there was no statistically significant difference between the two platforms. However, for searching activities, participants preferred iMac to WebTV (the Chi-square Test, $P<0.05$).

Table 3b includes preference ratings related to presentation of the material on the two platforms. With exception of the print size, iMac print clarity, clarity of picture, clarity of images, screen color, and screen brightness was preferred ($P<0.05$)

Table 3a. Platform of preference in performing the tasks.

Category	Total	X^2 (df = 1)	p-value
Searching		4.122	0.042
WebTV	14		
IMac	27		
Navigating back		1.256	0.113
WebTV	16		
IMac	23		
Navigating by typing		0.714	0.606
WebTV	15		
IMac	20		
Navigating within a website		1.976	0.160
WebTV	16		
IMac	25		
Scrolling up & down		2.189	0.162
WebTV	14		
IMac	23		
Open & reply to email		0.023	0.879
WebTV	21		
IMac	22		

Table 3b. Platform of preference in terms of onscreen presentation quality.

Category	Total	X^2 (df = 1)	p-value
Print size		2.814	0.093
WebTV	16		
iMac	27		
Print clarity		13.889	< 0.001
WebTV	10		
iMac	35		
Clarity of pictures		17.780	< 0.001
WebTV	7		
iMac	34		
Clarity of images		16.900	< 0.001
WebTV	7		
iMac	33		
Screen color		9.757	<0.05
WebTV	9		
iMac	28		
Screen brightness		12.902	< 0.001
WebTV	9		
iMac	32		

Because our sample contained a surprisingly high proportion of subjects indicating they were 'Somewhat' or 'Very Comfortable' using a computer, we analyzed whether frequency of use of a computer was related to a subject's preference ratings. Frequency in using computers was statistically significant related to preference ratings for the tasks Navigating Back, Navigating by Typing, and Navigating within a Website. For those three activities, iMac was preferred over the WebTV platform (the Fischer Exact test, $P<0.05$, ranged from 0.0088 to 0.0329). (Table 4)

Table 4. The impact of the frequency of using a computer on the platform of preference in performing the tasks.

Tasks	WebTV	iMac	p value
Searching			>.05
Never	6	2	
<5 times/mo	2	3	
6-10 times/mo	1	2	
>10 times/mo	5	20	
Navigating back			0.0244
Never	5	0	
<5 times/mo	3	2	
6-10 times/mo	1	2	
>10 times/mo	7	19	
Navigating by typing			0.0329
Never	4	0	
<5 times/mo	3	1	
6-10 times/mo	1	2	
>10 times/mo	7	17	
Navigating within a website			0.0088
Never	7	1	
<5 times/mo	2	2	
6-10 times/mo	0	3	
>10 times/mo	7	19	
Scrolling up & down			>.05
Never	5	2	
<5 times/mo	1	3	
6-10 times/mo	0	3	
>10 times/mo	8	15	
Open & reply to email			>.05
Never	5	2	
<5 times/mo	3	2	
6-10 times/mo	0	3	
>10 times/mo	13	15	

Discussion

There are many choices to make in selecting the type and configuration of the electronic platform to use in providing optimal patient education over the Internet. This study focused on two basic platforms, the Web-TV and the iMac.

The two devices quickly showed their salient characteristics. The iMac is a full-fledged personal computer, with all the power and complexity inherent in such a device. It has a keyboard and a mouse and a certain amount of space in the home would need to be set aside for it. It easily handles complex multimedia content, such as streaming video and Java. It requires occasional system maintenance by an expert to keep it running smoothly. Although easy to troubleshoot as computers go, the computer novice would likely be at a loss, at least at first, should something go wrong with its complex operating system.

The WebTV is a set-top box that hooks into the user's television, much like a VCR. It uses only a cordless keyboard, simplifying some navigation issues. It connects easily and requires no system maintenance. Although the interface is welcoming and attractive, TV sets use different display technology (interlace) than computers (non-interlace) which make it necessary to render text in large type for the sake of legibility. This means that not as much content will fit on the screen. WebTVs also cannot stream video, run Java, or display much in the way of advanced HTML content necessary for the delivery of compelling content.

The pie charts that follow this report (in the section before the Attachments) show that in terms of total counts, the iMac is generally preferred by the majority of study subjects. However, this difference in total counts preferring one platform over the other does not mean that these differences are statistically significant. (That is, that these differences in total counts did not happen by chance alone.) Because the study sample size was relatively small, the difference in total counts would have had to have been relatively large to reach statistical significance.

Overall, this study found no statistically significant difference in platform preferences for performing any of the required tasks, with the exception of Searching (iMac was the preferred platform). However, it is also important to interpret this finding in light of the relatively high comfort level that our study subjects reported in using any type of personal computers (whether Apple or PC) and the relative frequency with which they reported using computers. Although we initially selected this population of volunteers because we thought they were likely to be comparable to our diabetes patient population, further evaluation of our Diabetes patients will be required to determine whether that is, in fact, the case. It is also important to note that the one task which our five non-computer subjects were unable to complete in the 15 minute time limit was opening and responding to an email.

The finding that the iMac screen presentation was preferred for all items except Print Size merits further discussion. First, it must be recognized that the Web TV uses a basic television monitor having relatively poor resolution in comparison to the iMac monitor. Clearly, the better quality monitor also increases the potential cost of deploying a iMac or other personal computer based educational intervention in patients' homes. Finally, it should be noted that over 80% of the study sample wore glasses, thus reinforcing the importance of considering the visual quality of any material being presented. Beyond the scope of this study, the question remains whether patients will more efficiently or effectively be able to understand and integrate information because of the quality of the visual quality differences in a Web TV or iMac based platform.

Study Limitations

The study reported here has some inherent limitations. First, study subjects were volunteers from a hospital volunteer office in a large academic medical center. The generalizability of this sample can ultimately be questioned. As a group, they may represent a somewhat better educated, somewhat more financially secure, and more computer experienced group than may be typically found in the general population. Secondly, given the limited scope of this study, there was no attempt to measure actual learning and retention using one platform vs. the other. And finally, each subject spent relatively little time with either platform. An evaluation of extended use on these platforms would provide much more definitive information about the relative advantages and disadvantages of each.

Our focus was primarily limited to determining for each platform 1) whether or not a limited number of specific tasks could be performed in a defined time period, and 2) whether the subjects' preference for the on-screen quality and presentation of the material varied from one platform to the other.

Conclusion

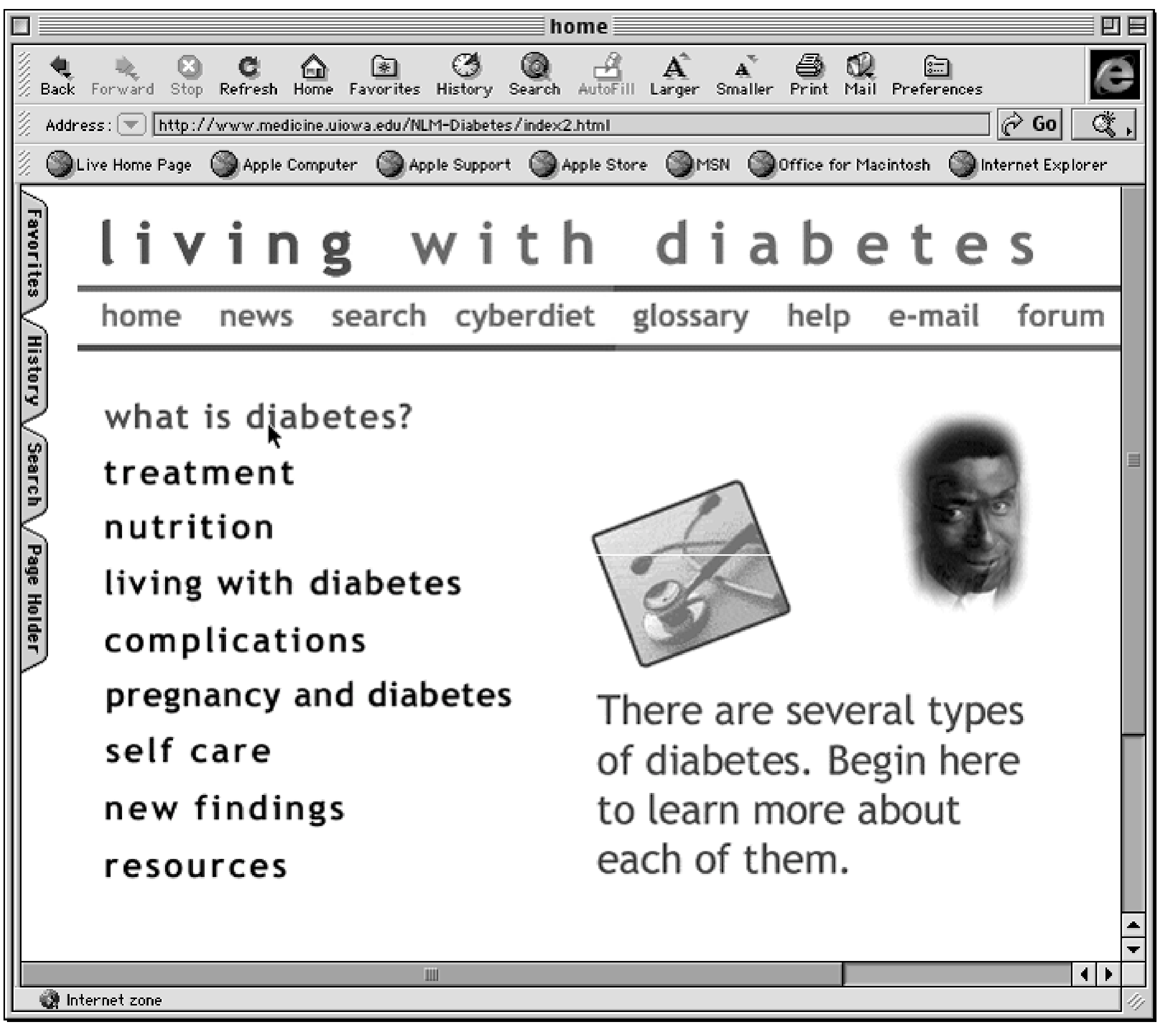
With regard to criteria evaluated on the quality of images and screen, the iMac was shown to be preferable over WebTV. For the tasks performed, the differences between the iMac and the WebTV may not be statistically different. In activities relating to searching and navigating, the iMac was again found to be preferable, particularly for those volunteers who used computers frequently. From the content development perspective, the iMac was more flexible and receptive to the strategies we intended to employ for the benefit of patient education.

Grinnell Regional Medical Hospital: Diabetic Subjects Recruited for Patient Education Study

Having decided on our delivery platform, our next step was to determine the effectiveness of delivering diabetes education using the Internet and a home computer. To that end, we designed a prospective, randomized, crossover study designed to compare volunteers allowed access to the diabetes web site compared to a control group without such access. Sixteen iMac computers had been purchased for this part of our study. Accordingly, we sought to recruit 32 volunteers. We designed a flyer (attachment 5) which was then distributed by Karole Conaway, RN, diabetes education coordinator at Grinnell Regional Medical Center. The study design called for randomly assigning subjects to computer use (study) or no computer use (control) for three months, after which the groups would cross over.

Thirty diabetic patients were recruited for the study and received training at one of two sessions scheduled in early December, 1999. Twenty-three subjects attended the first meeting and seven attended a second. At each meeting, volunteers in attendance were stratified by gender and ranked according to body mass index determined through height and weight measured at the time of the meeting. Each subject had to sign and date an Information Summary and Consent Document (attachment 6). For each gender, beginning at the highest body mass, index blocks of two subjects each were randomly assigned to receive initial computer training (study) compared to no such training (control). The baseline characteristics of the study recruits are shown in Table 5. Subjects randomized to computer use received group and individual instruction in the use of the diabetes web site, e-mail, online forums, and in the use of the computer in general. Subjects were encouraged to use the web site and use of the site is currently being monitored by the remote server in Grinnell.

The NLM diabetes web site was designed for the iMac platform and ease of use. Features like CyberDiet, e-mail and a group forum provided study participants with tools to plan meals, share recipes, or hold a threaded discussion on a topic of their choice. We also included a wide variety of links to other quality web sites for persons with diabetes.



All subjects (computer users and controls) were administered a knowledge questionnaire and a computer use survey prior to randomization (attachments 7 and 8). In addition, a blood sample was obtained from each participant for measurement of hemoglobin A1c that is a well-established biochemical marker of average glycemic control over the prior 2 to 3 months.

Table 5 The baseline characteristics of the recruited population

	Initial computer	Initial control
Number	15	15
Age	51 +/- 6	51 +\- 9
Body mass	32.70 +\- 3.49	34.57 +\- 3.98
Number female	7	8
Hemoglobin	7.8 +\- 1.2	7.9 +\- 1.0

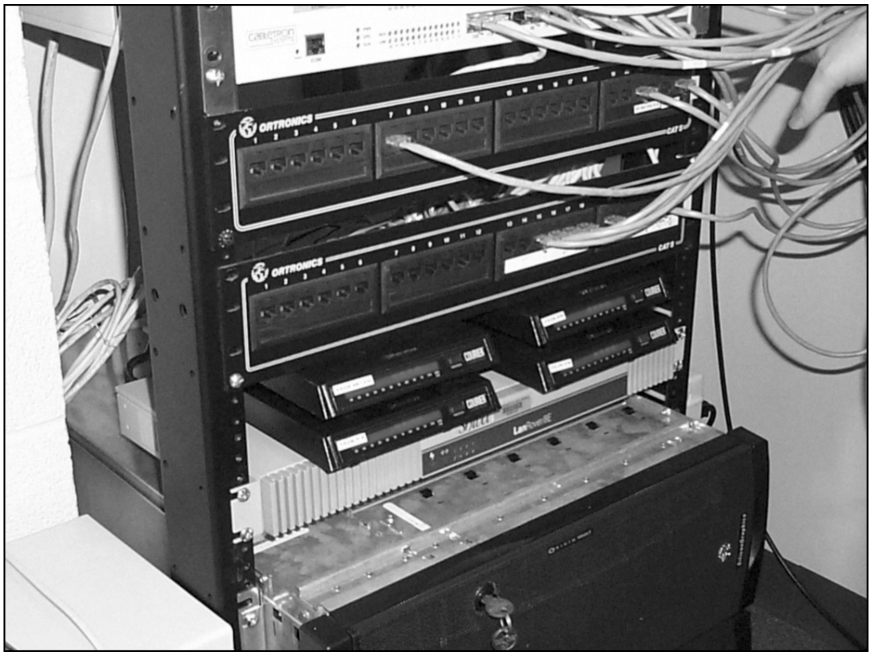
Data represents mean +\- sem

Technical Preparations

To accommodate the in-home study, significant logistical and technical planning was required. The technical preparations, user training, and subsequent distribution of the iMacs proved to be one of the most challenging aspects of the study to date.

Setting Up Remote Access Server

Tom Bullers, technical coordinator, was responsible for evaluating, selecting and implementing a remote access solution to accommodate the study. After researching three different systems, he recommended the installation of Shiva System and the purchase of four modems to support up to 16 users. (See below.) His research and recommendations resulted in activating hunt grouped phone lines from GTE, and the installation, testing, and configuration of a Shiva LanRover 8E. One benefit of the product was that Telecommunications Services had this product in stock and was familiar with its use. Another benefit was its ability to provide real-time logging of patient access.



To support the in home study, Tom Bullers, technical coordinator, researched and tested a variety of options for dial-up services. The Shiva LanRover 8E was selected and installed. Four 56k modems provided access for up to 16 users. The Shiva is capable of real time activity logging, capturing valuable data on user activity.

Jerry Gilmere, training specialist and user support, researched 10 different phone service areas in and around Grinnell and determined that most were going to be long distance calls to the Grinnell Regional Medical Center. This required us to re-think our approach to supporting our long distance connections to the remote access modem pool. We had to be able to provide both local and long distance dial up capabilities. To solve the problem we established a long distance account with an 800 number for our long distance connection to the server modems. Our study participants originated from 14 different communities spanning six counties, and seven participants from the iMac group required long distance dial up.

E-Mail

Establishing e-mail accounts for the study participants proved to be particularly challenging. The problem was we had no idea which participants would be selected for the iMacs until the randomization process was complete – two days before we sent the patients home with the computer. It was clear we needed an e-mail system that would give us the ability to quickly access and administer changes to user accounts. The solution was our campus UNIX e-mail system. This allowed us to quickly establish 20 generic accounts and a distribution list with the campus list server. Tom was assigned administrative rights that in turn gave him access to make the last minute changes.

Another facet of our e-mail support initiative involved the development of a web-based form that allowed our users to selectively choose multiple members from a mailing or "pick" list and then send a message to the selected group. Typical web-based solutions don't provide this capability. We researched CGI and JavaScript options, but chose to build a solution in Cold Fusion. While this solved the problem, we continue to monitor the system's use and effectiveness.

iMac Preparation

Considerable thought went into devising a streamlined process to prepare 16 iMacs for the study. We identified all software components that would make up the iMac profile, and agreed upon a two-phase approach to building out each machine. Phase I involved inspecting each machine, installing a RAM upgrade, and updating the firmware. These steps were followed by the installation of Apple's newest operating system–Mac OS 9–Microsoft Internet Explorer 4.5, Microsoft Outlook Express, Timbuktu Pro, and the Starbright Diabetes Education CD-ROM. When we purchased these computers earlier in the year, the current operating system was OS 8. However, we wanted the extra functionality of the OS 9 system to ensure optimum interaction with end users. These were the fundamental components installed and tested on each iMac before proceeding to Phase II. To expedite the configuration process, we utilized a free software tool called Revrdist, that allowed a single iMac system "image" to be created then cloned to all the other iMacs over a network.

Preparing for the user training session and iMac distribution required a tremendous amount of planning. Nearing the end of an 11-hour day are from left, Tom Bullers, technical coordinator; Bryan Sheeley, production coordinator, and Stephanie Anderson, training specialist and user support. Not pictured is Jerry Gilmere, training specialist and user support.

A set-up support kit was created and packaged with each iMac for the patient volunteers. The kit included: a color-coded surge protector, two color-coded phone cables, a dual-outlet phone adapter a grounded power cord adapter, an instructional video for iMac set up, a mouse pad, and a Starbright Diabetes Education CD-ROM. This kit was created to help study participants with the set up of their iMac.

Phase II was performed the night before the training session at Grinnell Regional Medical Center. All iMacs were unloaded and moved to the training room. All training support equipment was also unloaded and eventually set up for the following day's training session. Each iMac required individual configuration of the components installed and tested in Phase I. This tedious process was expedited by the installation of an Ethernet Hub and the use of one iMac as a file server. Phase II required 4 people working approximately nine hours, including travel time. To configure each iMac we used the following checklist:
iMac Configuration Checklist

- Assign iMac to study participant; label the iMac, the box, and the iMac NLM support kit.
- Establish and confirm E-mail account for iMac and user; make necessary changes in the Internet set up and Microsoft Outlook Express preferences.
- Create Remote Access Settings for Ethernet (Grinnell Training) and Home Dial Up; test changes, save settings, and test analog dial-up.
- Determine if iMac user will require long distance dial up; configure dial-up string accordingly in Remote Access Settings.
- Set Remote Access Option setting for "Connect automatically when using TCP/IP applications."
- Copy Video Vault web application to local drives of every iMac. Create custom icon and alias for Video Vault, place alias in Launcher items folder in the system folder. Make sure icon appears in launcher window.
- Add Timbuktu alias to the desktop and place copy in the Launcher Items folder in the system folder. Enable Timbuktu Pro in the Extensions Manager. Check to make sure Timbuktu appears in launcher window.
- Create New Address book in Timbuktu for each member of the diabetes technical support team.
- Make sure that the iMac has correct Launcher window configuration. Should have icons for Remote Access, Microsoft Outlook Express, Internet Explorer, Timbuktu, Video Vault, Search, and the Starbright CD.
- Disable Time Synchronizer and Location Manager in Extensions Manager.
- Test for local access dial up (we need to have the 9 in the dial string). Remember to remove the
  9 in the dial string prior to shutting down and re-packing the iMac.

Training

A training outline was created with a heavy emphasis on hands-on activity (attachment 9). With a presumption of great variability in terms of computer competency, it was considered important that each user demonstrate operating skills before leaving the training room. The home activities that the volunteers would perform were broken down into basic competencies. These were introduced, demonstrated, and practiced during the course of training.

The study was introduced and the training proceeded through the use of a moderated PowerPoint presentation, viewing the set up videotape, and guided practice on their personalized iMac computers. Exercises included powering on the computers, launching applications, navigation of the NLM Diabetes web site, live web searches, and sending and receiving e-mail messages. Technical support contacts and local medical support links were introduced.

The entire training process was scheduled on Saturday, December 4^{th} from 9 a.m. to 3 p.m. This included two breaks and a catered meal for the study participants. Two training sessions were required to accommodate the first 12 study participants.

User Support

On-going technical support is available to the study participants via e-mail and the forum, both accessible on the web site. A technical support line is monitored Monday through Friday from 8 a.m. to 5 p.m. This technical support line is a toll-free 1/800 number that rings into the Telemedicine Resource Center and then is transferred to diabetes project staff. A voice mail system handles calls in the evenings and on weekends.

Another method of support is the ability to establish a direct connection between our support staff and the end user's iMac using Timbuktu Pro. Timbuktu allows support staff to direct the iMac of a remote user. This helps us identify, and when possible, repair the problem without extensive travel.

We have established a web-based call logging system and database to track the number of calls, their nature, and steps that were taken to resolve the problem. We also have the ability to monitor user activity and maintain a strict level of confidentiality for the study participant.

Control Group

The group of patients who did not receive computers were asked to rely on the same pattern of information gathering that they used in the past. For example, obtaining brochures from their physician's office, talking to other patients, or noting information provided in the popular media. This group was pre-tested at the beginning of the study along with the study group who received computers. The control group will be post tested at the end of the 90 day study period so that the results can be compared with those of the computer use group.

Current Status

At the time of this writing, it has been approximately 90 days since the initial randomization of the subjects. Another group meeting was held, tentatively planned for February 26th. At that time, weight was again measured to determine body mass index, the knowledge questionnaire will be administered again, and blood samples obtained to measure hemoglobin A1c. The computer use group completed a follow-up computer use survey. The groups then crossed over. Those subjects who did not use the computer for the initial three months received computer training. They were given the iMac computers for a three-month period and, as before, web site use will be monitored. After this second three-month period, all subjects will again be administered the knowledge questionnaire, body mass index determined, and hemoglobin A1c again measured. The group who used the computer the second three months will complete the follow-up computer use survey (attachment 10).

The results over the first three months of the study will determine the increment in knowledge as well as differences in glycemic control and body mass index between the two groups.

Over the second three month period, we will determine whether prior control subjects will improve glycemic control having been given computer use. For the control group (computer users over the first three months), we will determine whether knowledge, glycemic control, and any potential change in body mass index will be sustained.

<u>Please note:</u>

The University of Iowa has agreed to pay the circuit and line charges to Grinnell Regional Medical Center until June 30, 2000 so that the crossover study can be completed. Although the NLM contract officially ends March 31, 2000, we will submit the final project evaluation to the NLM as an Addendum in late Summer or early Fall, 2000.

<u>Lessons Learned</u>

- Over the course of the contract we worked toward building a capability that would provide diabetes patients an opportunity to supplement their education and improve their ability to manage their diabetes.
- Our approach assumed that fundamental educational materials re-engineered and delivered using technology and interactive multimedia techniques would provide a compelling learning experience for the end user, resulting in a measurable improvement of a patient's ability to control their blood glucose.

<u>Technology Creep</u>

To accomplish our goal we set out to create a combination of content and technology that could be easily introduced in the home and a slightly more sophisticated capability designed for patient access to high quality video content in the hospital. In 1996 we began the process of researching the availability of a device suited for patient use in the home, and the necessary technology that would allow delivery of high quality video to devices in the hospital. Over the next 18 months we were able to identify, test and adopt the best technology available. However, we quickly learned that despite our best intentions, the pace of the computer industry had a significant impact on our ability to adopt a platform or device that showed any staying power. Innovation in the computer industry was growing exponentially, making it extremely difficult to make a commitment to one solution over another. Our experience with the Pippin device is indicative of the technology creep we witnessed early in the contract.

Options for a set-top device well suited for the home were limited at best, and finding one device that offered all of the features we were looking for was even more difficult. After Bandai abandoned the Pippin device, we turned to the WebTV. Despite the limitations of the platform, it was the only option available to us without taking the next step up to a desktop computer. Initially we wanted to avoid taking this step for fear of alienating patients who, for the most part, might have limited experience with computers of any kind.

WebTV and subsequently WebTV Plus was a flawed platform for our purposes due to its lack of support for Java, JavaScript, limited audio capability, and the absence of any support for video playback. Usability was also a concern due to its small screen size and a disconcerting reliance on scrolling through long pages dominated by large text cramped on a television screen. Usability is the most important element of multimedia and web design. Dr. Jakob Nielsen, a leading expert on usability and interface design, is User Advocate and co-founder of the Nielsen Norman Group (http://www.useit.com). Please see Dr. Nielsen's usability review of the WebTV (attachment 11) for additional information.

Shortly after we began to develop content for the WebTV platform, Apple Computer, Inc. announced the iMac. The iMac was a desktop computer designed for the consumer and promised ease of set up and ease of use. The platform also offered everything that was missing on the WebTV platform: CD-ROM support, full motion video (QuickTime), stereo audio, and broad support of multimedia file formats. Unlike Apple's original Pippin device, the iMac was introduced as a powerful computer, and the company was counting on a boost in sales to recapture market share and its reputation as the platform of choice for multimedia development, the education community, and the home consumer. Apple began shipping the iMac in August 1998 and by November had shipped over 900,000 units. It was clear Apple had a user-friendly solution for novice computer users. The computer also had a competitive price point of around $1,100.

We continued to develop our content for the WebTV, but in the meantime ordered an iMac for testing. The iMac proved to be an excellent choice for our project, but before we made a commitment, we decided to conduct a usability study of our own to compare the two platforms. The usability study, or platform comparison, supported our decision to move to the iMac platform for our in home study.

In retrospect, our early focus on technology should not have been our top priority. We had no way of anticipating the extent to which technology would change over the course of the contract. We would have been better served beginning our project by creating a project plan based on an adult learning methodology and content design.

Mission Creep

As a result of a limited choice of platform, we had difficulty keeping any kind of development cycle. Each change in technology required a new approach to design, development, and delivery. As a result, mission creep was a common occurrence, and it was not until we adopted the iMac that we were able to proceed with some assurance of success. Better project planning would have helped to reduce mission creep, but it would not have eliminated it entirely. The nature of the project itself was dependent upon technology that continues to change and a user community whose technology skills and experience may not be generalizable. This combination represents the primary challenge we faced throughout the contract, and is ultimately indicative of the problems inherent in bringing patients and technology together.

Overall recommendations

We were able to introduce iMacs in the homes of 16 patients who are members of the Grinnell Regional Medical Center Diabetes Education Program. Fifteen other patients wait their turn to receive the iMacs at the crossover of the study that will occur on March 11, 2000.

In the short time we have had iMacs in the home, we are already seeing those areas where patients find the most levels of comfort. Interactive features such as e-mail and the user forum draw the most attention and the more experienced patients are already broadening their knowledge by accessing a wide variety of diabetes web sites and related on-line resources. We've added a printer to our in-home workstations to give individuals the ability to locate, sometimes customize, and then print material for future reference. While this required some additional planning and training, early indications are that patients like to print hard copies of what they find.

More emphasis needs to be put on training if we hope to promote the implementation of health education in the home using a computer or similar device. In some cases, it is an aging population of persons with diabetes and other types of chronic illness that stand to gain the most from health education information in the home. However, this is the same population that may be the least prepared to embrace the technology required to obtain it. Therefore any program that incorporates the use of technology like the iMac, WebTV or other *information appliance* needs to include a sizeable training component to offset a lack of computer experience or what is sometimes called "technophobia" by the end user. As the Baby Boomer generation reaches retirement age, we may see a population that can begin to take advantage of information services and technology without a substantial investment in end-user training.

A more precise and consistent understanding and use of adult learning strategies needs to be included throughout the process of planning, development and implementation. Planning and implementing this process needs to anticipate changes in technological and social trends over time in order to remain dynamic and effective. While the heart of this study is clinical in nature and in practice, one cannot ignore the subjective nature of the end-user in terms of experience and their ability or inability to retain information. By adopting an adult learning methodology as the basis for design, development and measurement, both objectives can be achieved, and better tracking mechanisms can be introduced to measure outcomes.

Also at the heart of our study lies the assumption that technology can provide caregivers an additional tool to reach patient populations who may not otherwise have the resources or ability to visit clinics and hospitals on a regular basis. Persons with diabetes living in rural Iowa are faced with the reality that the state has only seven certified endocrinologists. Four of these professionals are located at the University of Iowa Hospitals and Clinics. The proper use of technology is one way to reach out to this patient population and improve each patient's ability to self-manage their diabetes and end some of the feelings of isolation felt by patients, particularly at the time of diagnosis. The proper use of technology must include a substantial investment in evaluating and applying educational strategies, providing patient training and support, and measuring outcomes.

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Anecdote received from computer study patient at Grinnell Regional Medical Center on March 15, 2000.

"I am really enjoying this experience, and I think it is having a lasting affect on me. I am now testing my sugars 4 times a day when I used to not test them at all...I am also learning things about my diet and the food that I eat. All of my blood sugars before where over 300 and now I am slowly bringing them down to the 100's...I think this has given me the help that I have needed for so long...thank you so much for approaching me with this great rewarding opportunity..."

TELEMEDICINE TO CHILDREN WITH DISABILITIES.
DENNIS C. HARPER, PH.D., PROJECT DIRECTOR

<u>Introduction and Overview</u>

Among the estimated 50,000 to 70,000 children in the state of Iowa who have disabilities, there is a host of primary diagnoses including neuromuscular disorders, myelomeningocele, Down syndrome, mental retardation and other types of chronic health concerns. For those with more severe disabilities, these primary diagnoses are frequently compounded by secondary disorders, including chronic health problems resulting from the etiologies of the primary disorder and/or associated problems such as self-injury. Despite the high quality primary care and services to children with disabilities in Iowa, a significant number of these children exhibit complex anatomical, physiological, and/or behavior problems that require expert interdisciplinary evaluations and care planning that frequently are unavailable in their local communities.

The University Hospital School (UHS) one of the hospitals of the University of Iowa Hospitals and Clinics (UIHC), is Iowa's only tertiary resource dedicated exclusively to serving children with disabilities, their parents and family members, and their community care and service providers. Through the clinical services of the Division of Developmental Disabilities (DDD), Department of Pediatrics, and its professional staff, the UHS provides medical and comprehensive interdisciplinary associated with over 4,000 clinic visits per year addressing complex, inter-related arrays of disorders. Over half of these patients are scheduled for follow-up clinic visits in UHS. In addition, as many as 200 children are admitted annually to its seven (7) bed inpatient unit for short-term care that is not available in local communities.

These clinical services are organized to bring tertiary expertise to each family as needed from specialists in audiology, dentistry, education, medicine, nursing, nutrition, occupational therapy, physical therapy, psychology, social service, speech-language pathology, and rehabilitation engineering. These professional staff are organized into specialty care teams to most efficiently meet the needs of selected patient cohorts.

The families of children, often accompanied by community service providers, travel from throughout Iowa to the UHS for these specialized interdisciplinary services. It has been demonstrated that local service providers can complete plans of care once the nature of the problems have been identified and the plans for management have been designed (e.g., Cooper, Wacker, Sasso, Reimers, and Donn, 1990). Consequently, the bulk of the clinical services of the UHS provide in-depth evaluations on an outpatient basis with recommendations formulated in collaboration with local care and service providers, and families.

It has been documented (Hoyt, D.R., and Mack, K.Y., 1996) that barriers to these services exist, such as parents' travel expense or loss of time from work. The distance of the facility from the patients' home communities also results in referrals not being made for children who need the tertiary level care. The problem is compounded by the multiple community services involved with these families (e.g., primary care physician, special education agencies, local school districts, social services), and it is difficult to optimally coordinate carrying out the recommendations for care and management.

UHS clinical staff also conducts outreach clinics in an attempts to resolve the previously mentioned barriers. For example, UHS physicians and interdisciplinary staff conduct outreach clinics through the state Child Health Specialty Clinics1 (CHSC) for children with Down syndrome. Involvement of primary care physicians and community services is facilitated, but this mechanism is costly and inefficient for UHS staff. A UHS team consisting of a physician, psychologist, speech/language pathologist, and educational specialist travel to local communities to observe and examine children who have significant behavioral and learning disorders frequently resulting in the children being brought to the UHS to be seen by an on site specialty team. We now anticipate attempting to offer selected aspects of service through our telemedicine program on an ongoing basis.

<u>Rationale for Project</u>

The project was developed to test the potential of the Iowa Communications Network (ICN), a statewide fiber optic system, to assist the UHS to provide these selected tertiary level services in a manner that is optimally efficient for parents of the patients, community care and service providers, and UHS staff. An ICN studio was constructed at UHS and became operational in March, 1996. The studio is designed to provide optimum flexibility for live, fully interactive clinical service delivery.

Scope of Project

This project was designed to evaluate selected clinical services that are now provided on site in UHS that can be provided by this telemedicine approach. The primary questions of this project focus on:

- What types of selected clinical services or components that are now provided on site at UHS can be offered over the ICN effectively?
- What is the satisfaction and reported effectiveness of providing telemedicine consultations to children/families and providers in a rural state in the view of families and their providers?

Types of Care Designed

The following are among the types of clinical care that were developed for delivery over the ICN to children who have disabilities:

- Providing initial, specialized interdisciplinary evaluations and/or consultations by UHS staff observing, from the UHS studio, children's responses to examination procedures and interactions with local care and service providers in a community studio.
- Providing follow-up evaluations of children subsequent to initial evaluations that have been completed on site in the UHS or that have been conducted over the ICN as in (1.), above. These follow-up evaluations would be performed by UHS staff in the UHS studio, observing the child in the community studio as he or she interacts with community service providers.

Catchment Area and Study Sample

The off-site resources available and the arrangements for collaboration that were made in Ottumwa, Iowa, made a ten (10) county area in southeast Iowa an ideal catchment area for the project. There are two ICN studios that are immediately available for the project, one in the Ottumwa Regional Health Center (hospital) and one in the central office building of Southern Prairie Area Education Agency 15 (AEA 15). There were multiple sources of patient referrals in the Ottumwa area that initiated these telemedicine services.

One source of referrals was the staff of AEA 15. AEAs in Iowa serve as the intermediate service agencies to provide special education and related services to children with disabilities in Iowa schools according to Public Law 102-119 (1994). AEA 15 provides these services to 3,575 children with disabilities in the 24 school districts in the 10 counties of the catchment area. That agency agreed to act as the local coordinating agency.

The other sources of initial referrals were: Jay Heitsman, MD, a private practicing pediatrician in Ottumwa, Iowa, who serves as the pediatrician for the CHSC, regional clinics in the Ottumwa area, and also interacts with other pediatricians in the area using the ICN studio in the Ottumwa Regional Health Center; Cheryl Jones, ARNP, CPNP, a Regional Health Coordinator for the CHSC in Ottumwa who is available in the community as these services are implemented to assist the primary care physician and/or assistants and who coordinates the activities of a community team for children with swallowing disorders; Debra Pumphrey, MSW, a caseworker for the Department of Human Services in Ottumwa, referred children with behavior disorders.

Phase I: Formative Development of Procedures

Specific Objectives
This project had the following objectives:

Objective A. To Design and Implement Telemedicine Clinical Protocols for Four Cohorts of Pediatric Patients With Disabilities.

Protocols were to be designed to provide the care called for in initial project goals or variations thereof, for four cohorts of children/patients with disabilities: those who have (1) special health care needs, (2) severe behavior disorders, (3) swallowing disorders, and (4) need for a high level of assistive technology – augmentative communication.

Design of the Clinical Protocols

The protocols were designed in collaboration with the involved community professionals. Consequently, those community care and service providers were familiar with the procedures and their ramifications. This cooperative development of clinical protocols was, and remains, a key aspect of the overall success of telemedicine in our view. The success of telemedicine in completing interdisciplinary evaluations is clearly enhanced when protocols are developed collaboratively by the referral (distant) and evaluation (UHS) site, Appendix A.

Scheduling and Intake Procedures

All of the ICN services were scheduled through the UHS intake process, thus assuring that needed pre-service information is available to UHS staff, that the most appropriate UHS physician and interdisciplinary staff are scheduled for the services, that an appropriate clinical record is established, and that any needed follow-up service through the ICN, on-site at the UHS, or in clinics of the UIHC is scheduled, Appendix B. These are described in detail under Objective B to follow.

Protection of Patient Confidentiality and Evaluation

Other requisite consistencies in the protocols were those procedures established to protect the confidentiality of patient information and those for evaluating the telemedicine services. These are presented in Section B.

Formative and Summative Development of Clinical Protocols

A protocol was development to guide the general etiquette and procedures of all telemedicine consultations. These procedures guide the initial interactions of the participants during the entire consultation session. They represent a model developed based upon our clinicians' group view of patient/family/professional interactions. These particular procedures are idiosyncratic and specific to this location; nevertheless they provide, as all our protocols, a general template to review when implementing a telemedicine consultation.

The following general protocol for initial and follow-up evaluations describes activities originating at the distant site and originating at the local site. Procedures although similar have important differences. Please see glossary for acronym definitions. Appendix B.
Protocol to Guide Scheduling, Implementing, and Documenting Clinical Assessments: Initial Patient Assessment Occurring in Local and Distant Studios

Prior to ICN Assessment
- Local clinician identifies need for assessment
- Need verified by local PNP or MD
- Community coordinator contacts UHS ICN scheduler to initiate discussion regarding appropriate date
- UHS ICN scheduler contacts team leader to initiate discussion regarding appropriate date
- UHS ICN scheduler contacts community coordinator with potential date(s)
- Community coordinator works with local clinician and verifying MD or PNP to determine appropriate persons to be present in local studio on date of assessment
- Adult to present "question(s) under consideration"
- Adult to respond to current health history
- Medical/health clinician to discuss current medical care (unless available via written format)
- Patient under consideration
- Local health care professional to demonstrate medical findings if appropriate
- Team leader notifies UHS ICN scheduler of assessment date
- Team leader determines persons to be present in UHS clinical studio and notifies UHS ICN scheduler
- Team leader determines "clinical equipment" required to be in local studio and notifies UHS ICN schedule
- UHS ICN coordinator notifies community coordinator of clinical equipment necessary to be available in local studio
- Team leader determines need for "technical equipment" to be present in local studio and notifies UHS ICN scheduler
- UHS ICN scheduler notifies community coordinator of technical equipment required to be present at time of assessment
- Community coordinator initiates signing of permits from those attending assessment in local studio
- Community coordinator faxes signed required permits to UHS ICN scheduler

- Community coordinator, 24 hours prior to assessment time, verifies session is a "go" and contacts UHS ICN scheduler if any difficulties
- Following ICN Assessment
- Determination of a Plan of Recommendations
- Team leader indicates to local studio personnel that assessment phase has been completed, requests local personnel to complete data input, and initiates discussion leading to generation of a plan of recommendation
- Team leader makes initial statement, asks for initial statements from associate team members
- Plan of recommendations related to primary question is formulated, clearly presented to local personnel with request for immediate response from parents, patient, and care providers
- Plan of recommendations related to secondary questions is formulated, clearly presented to local personnel with request for immediate input from parents, patient, and care providers
- Plan of recommendations is documented in appropriate UHS clinical forms
- Written plan of recommendations is forwarded to appropriate local personnel
- Process-oriented Activities
- Community coordinator evaluates reason for 'no go' and coordinates corrective actions if necessary
- Community coordinator initiates rescheduling process if a 'no go' situation occurs
- Team leader documents clinical assessment on appropriate UHS clinical forms
- Team leader conducts in-house subjective review of team process immediately following clinical assessment
- Team leader informs either community coordinator or UHS ICN scheduler of any needed changes resulting from subjective review of team process prior to next scheduled assessment

Patient Assessment in Local Studio Subsequent to Prior Assessment (Follow Up).

Process and protocol similar to initial evaluation except that UHS personnel may initiate request. They should notify UHS ICN scheduler who contacts community coordinator to initiate process.

Patient Assessment Occurring in UHS (On-site) with Subsequent ICN Interaction with Local Care Providers in Local Studio

Prior to ICN Assessment

- Local clinician identifies need for assessment
- Need verified by local PNP or MD
- Local clinician notifies community coordinator
- Community coordinator contacts UHS ICN scheduler to initiate discussion regarding availability of ICN dates
- UHS ICN scheduler contacts team leader to initiate discussion regarding appropriate date
- Team leader indicates need for tertiary-based assessment with follow-up of recommendations to local studio
- UHS ICN scheduler contacts community coordinator with team leaders recommendation and suggestions for potential date(s)
- Community coordinator schedules with UHS scheduling service and selects specific date

- Community coordinate works with local clinician and verifying MD or PNP to determine appropriate material to be forwarded to UHS prior to assessment date
- Team leader notifies UHS ICN scheduler of assessment date
- Team leader determines persons to be present in UHS clinical studio and notifies UHS ICN scheduler
- Team leader determines clinical equipment required to be in UHS clinical studio and notifies UHS ICN coordinator
- Team leader determines need for technical equipment to be present in local studio and notifies UHS ICN scheduler
- Community coordinator initiates signing of permits from those attending assessment in local studio
- Community coordinators faxes signed required permits to UHS ICN scheduler
- Community coordinator, 24 hours prior to assessment time, verifies that the session will take place and contacts UHS ICN scheduler of any difficulties

Following the UHS Clinical Assessment

A. Clinical Aspects

- Team leader and associates (those who assessed patient or who have appropriate input into recommendations phase of UHS outpatient process) convene in ICN studio
- Patient/parents/patient advocates convene in UHS clinical ICN studio
- Team leader verifies permission protocol with members physically present
- Team leader introduces team members in ICN clinical studio
- Team leader summarizes clinical findings and recommendations
- Associate team members present findings, opinions, and recommendations
- Parents and accompanying persons express opinions and responses to recommendations
- Plan of recommendations is documented on appropriate UHS forms
- Copy of recommendations is forwarded to parents and other appropriate local care providers

B. Process-oriented Activities

- Team leader notifies UHS ICN scheduler of 'no show' situation
- UHS ICN scheduler notifies UHS scheduling of now show status and requests family contact to establish need for rescheduling
- Team leader documents clinical assessment on appropriate UHS clinical forms
- Team leader conducts in-house subjective review of team process immediately following clinical assessment
- Team leader informs either community coordinator or UHS ICN scheduler of any needed changes resulting from subjective review of team process prior to next scheduled assessment

Individual Care Teams

Depending upon a variety of factors, children with disabilities often do not receive optimal health care services required by their particular circumstances (Capute and Accardo, 1996). This is particularly true for those with mobility and neuromotor related needs (e.g., those with cerebral palsy or post traumatic brain injury). Those with disabilities also often require specialized care for their specific disabilities for which their primary care physician and local health care team is often inadequately prepared to either diagnose or offer specialized treatment.

Evaluation

The Pediatric Brain Injury Team members recognize the importance of collaborating with individuals in the community. Telemedicine has allowed the team to interact with the family and a range of care providers in the local area in the southern part of Iowa. The evaluations, problem solving, and joint planning over the ICN results in more effective care for the individual with a brain injury. The Pediatric Brain Injury Team will become more readily accessible via the ICN to the entire state of Iowa, utilizing the brain injury resource teams available in each of the Area Education Agencies. The Pediatric Brain Injury Team at UHS is fortunate to have access to the brain injury consultant for the state of Iowa at the Department of Education. This individual will be available as the services expand throughout the state of Iowa. Please see Pediatric Brain Injury protocol in Appendix A. Further comments on the evaluation of this service are noted in a later section.

Children with Severe Behavioral Disorders

UHS has gained national recognition for its last decade of work in evaluating and recommending management of children with self-injurious and aggressive behaviors. These children most have mental retardation or other developmental disabilities. This clinical service includes outpatient evaluations by a team of professionals consisting of an educational specialist, pediatric nurse practitioner, pediatrician, psychologist, social worker, and speech-language pathologist. This same team provide the telemedicine services for this group of patients and families.

Patients were referred for evaluation of behavior disorders by local professionals. The objective of the telemedicine evaluations is to evaluate the specifics of their behavioral disorders. The evaluation (a) consists of a functional analysis to identify environmental variables related to the behavior, and (b) a behavioral treatment plan that most often involves communication training. The service will provide those who care for and work with the child a plan of these interactions through the following:

- A review of the pre-evaluation information supplied by the health professionals making the referral and the child's authorized representatives, care providers, or others who work with the child and, in selected cases, through correspondence and/or telephone conversations with UHS team members, to obtain a detailed description of the behaviors requiring modification, contingencies which seem to co-occur behavior, and medical and developmental variables in their history.
- The UHS team, in advance of the evaluation, planned the activities that are related to the functional analysis to identify the maintaining contingencies, or functions, of the problem behavior.

During the ICN session, the UHS staff:

- Coach the appropriate person(s) who conducts the onsite assessment by showing how to differentially provide varying consequences for the undesirable behavior (e.g., giving attention, withdrawing demands
- Analyze the patient's reactions to determine those interactions which reduce aberrant (inappropriate) behavior, and
- Discuss with the child's care providers and community professionals a plan to carry over the results of the plan into the child's daily living and the need for follow-up evaluations, arranging for a more detailed on-site evaluation in UHS if needed.
- Current Protocol: We provide three levels of service – (a) evaluations, (b) initial screenings, and (c) follow-up evaluations. The vast majority of our cases have involved follow-up evaluations, with screenings being the second most frequent level of service. The current protocols for initial and follow-up evaluations are described below, see Appendix A for protocol.
- Initial Evaluation Conducted over ICN – prior to ICN evaluation: In every case thus far, the local staff have received training in our clinic and thus are familiar with our assessment procedures.
- The local team completes a behavioral checklist (e.g., the Motivation Assessment Scale, Durand & Crimmins, 1988) that is focused on the environmental reasons for challenging behavior such as self-injury
- The local team interviews the care provider or teacher using an Antecedent-Behavior-Consequence (ABC) format
- The local team formulates hypotheses about the functions (environmental reasons) for challenging behavior
- The above information is faxed to our clinic team 1 or 2 weeks prior to the evaluation

- During ICN evaluation – The local team and care providers meet with our clinic team for 15 to 30 minutes to review hypotheses an to formulate the specific assessment conditions used in the brief functional analysis. The staff and child then enter the local studio and the functional analysis is completed in 60 to 90 minutes.
- The UHS camera is turned away from our clinic staff so that the screen is blank to the child but our team can still observe
- Approximately half of the assessment is completed and then the child takes a break for 5 to 10 minutes. During the break, the local and UHS teams discuss the assessment and make modifications
- The child returns and the assessment is completed
- The child leaves and we provide recommendations for follow-up. We often recommend that key test conditions be repeated in the classroom or home until stable levels of behavior occur.
- After ICN evaluation – Recommendations are faxed to the local team for follow-up.

Follow-up Evaluations

The initial assessment involves a functional analysis conducted within the Biobehavioral Service outpatient clinic.

Prior to ICN evaluation – A report from the initial clinic evaluation is mailed to the family and at least one phone call is made to the family to clarify recommendations. Approximately 1-week before the ICN evaluation, another phone call is made to determine the effectiveness of treatment and to clarify questions. The family (via local coordinator) usually invites all local service providers working with the family to attend the ICN, and most often all service teams are represented.

During ICN evaluation – Follow-up ICNs typically last for 30 minutes. Depending on the results of the phone call, three types of follow-up are conducted.
A treatment demonstration: The family or local service providers demonstrate their use of the treatment with the consumer, and the UHS team provides feedback or modifications
Promoting generalization: If treatment is working in some situations but not in others, we use the session to brainstorm options for generalizing the treatment. This has been, by far, the most common type of follow-up

Related concerns: If treatment is acceptable, but additional concerns have occurred, then we use the session to address those concerns. This frequently involves bringing in other team members from medicine, physical therapy, and education
After ICN evaluation – A report is generated and very often a video is made and sent to our staff. We most often schedule at least two follow-up evaluations, with the initial one being 1-month after the clinic evaluation and the remainder occurring at 3-month intervals.

Evaluation

The above protocol has remained the same for the duration of the project. The only modification has been to use follow-up evaluations much more frequently than initial evaluations. This has occurred because we learned that initial evaluations could only be done with trained staff.

The follow-up evaluations have been an overwhelming success. This success has occurred because (a) we are able to maintain more frequent contact with the families and other care providers than through our clinic; (b) we have been able to make frequent adjustments to treatment in a more timely manner, thus preventing severe outbursts; (c) a much broader array of local service providers is involved in treatment and works more closely together as a team; and (d) the family receives more support and positive feedback from the various teams working with their child. Overall, the ICN has functioned to increase contact among the various agencies and to increase the team feeling that the families and agencies have in working together.

We have three major objectives for future use of the ICN. First, we are attempting to secure Medicaid funding for the follow-up evaluations. Second, we are working with Des Moines Public Schools and Heartland AEA to further develop the initial evaluations. Third, we are hoping we can develop a screening system via the ICN. The purpose of this screening is to address mild problems quickly and to refer consumers to local services or UHS services in a timely manner. To date, we have written one grant (NIDRR) that would utilize the ICN extensively if funded, and we anticipate writing other grants. See Appendix A for protocol.

Children with Swallowing Disorders (Dysphagia)

There are increasing numbers of infants and young children who have swallowing impairments as a result of increased survival of prematurity, respiratory distress, congenital anomalies, and/or other pathologic insults. These children often have extremely complex health care needs. They require expert care and evaluation of their many problems that include impaired swallowing and the significant consequences of this problem.

Dysphasia results from abnormalities in the structure and/or function of the swallowing mechanism that disrupts the oral, pharyngeal, and/or esophageal phases of the swallow. These problems of structure and function are dynamic in the pediatric population because of the child's growth and development, as the anatomic structures essential for feeding undergo changes in size and physical relationships. Feeding skills also undergo change as a result of neurologic maturation and learning. Interpersonal and cultural influences can also have an impact upon the infant and child's swallowing impairment. Clinicians must consider the child's cognitive, motor, language, and behavioral status as well as their chronological age, and parent reports become crucial since the young child frequently cannot report information needed to localize pathology.

Evaluation

Approximately 33 infants and children were referred to the Feeding and Growth Management Service for evaluation/follow up of their swallowing and growth difficulties. The majority of these individuals were in the 0-5 years of age with a primary neuromotor (cerebral palsy) diagnosis. Approximately 50 % of all cases included a review of laboratory findings, which included viewing of current or past radiographic swallow study video to demonstrate the individuals swallowing mechanism and the evidence or lack of evidence of aspiration/penetration. This is exclusive to the ICN evaluation and is not something that is typically accomplished during an outpatient visit. However, due to the technology available within the ICN demonstration of the swallow study was easily accomplished. This single event greatly "leveled the playing field'' and educated all providers and caregivers to the origin of the specific recommendations. In addition, the Elmo (overhead projection device) allowed for demonstration of any feeding devices (gastrostomy tubes, buttons, ventilation tubing) to be easily viewed when reviewing care and management issue of such items, along with graphic materials such as growth charts. Oximeters at both sites allowed for objective observation of individuals oxygen saturation levels during oral feedings. Remote cameras with zoom capabilities allowed for direct observation of the individuals oral motor abilities and feeding skills. However, of greater importance than all the technology available in the room was the ability to assemble all caregivers involved in feeding the individual into one room and allowed them all to share impressions and develop family centered, coordinated planes. In addition, it provided them an opportunity to ask questions or obtain clarification of any issue. This lead to better management of the individual's overall needs.

Limitations of telemedicine services for management of feeding and growth issues include the need to relay on the interpretations of others during physical exam. At times the camera angles were not ideal to allow for clear pictures of the mouth during feeding. In addition audio volume and quality varied at times based on the cameras being used. Ironically, another potential barrier could be the assembly of all caregivers and service providers for the parent during times of disclosure as it relates to history gathering. The large assembly of people may also, at times, interfere with the need to observe the individual in a more "natural" setting, as most individuals do not eat with 10 different people watching. Although this mode of delivery is excellent for screening and follow-up a comprehensive initial evaluation is not always accomplished using telemedicine services.

The use of telemedicine services appeared to meet the needs of individuals, their caregivers, and local service providers in respect to feeding and growth issues. Beyond the obvious benefit of reduced travel and expenses for families and local accompanying service providers, the consensus of both teams was that it empowered the family and allowed for team building between local and tertiary teams. Future consultations are ongoing though out the state of Iowa.

The specific clinical protocol for the Feeding and Growth Management Services appear in Appendix A.

Children Needing Assistive Technology Services

The term “assistive technology" refers to products and systems that permit enhanced function by persons with disabilities, and that technology ranges from what is referred to as “low-tech” to “high-tech” devices (e.g., a display board of pictures by which a young child who cannot speak due to a neuromotor disorder points to pictures in order to communicate, compared to a sophisticated speech from preprogrammed, and/or keyboard inputted, messages for an older child). There are, literally, thousands of assistive technology devices now available that can enhance individual's abilities to communicate (both speaking and writing), perform educational tasks, and be independent in daily living activities and participation in community life.

The composition of the interdisciplinary team that prescribes assistive technology for UHS patients varies with the type of needs presented by individual cases (e.g., a physician, occupation therapist, physical therapist, rehabilitation engineer, and orthotist for postural support systems; a speech-language pathologist, an educational specialist, an occupational therapist and rehabilitation engineer, with consultation of a physician, for augmentative communication devices). The specific protocols to be developed and implemented to provide assistive technology services will vary as a function of the types of disabilities of patients and the technologies to be obtained/designed.

Evaluation

The University Hospital School Augmentative/Alternative Communication Service had completed 30 telemedicine sessions. Ninety percent of all clients had a primary diagnosis of neuromotor dysfunction (cerebral palsy) and a secondary diagnosis of some degree of mental retardation. The majority of these individuals were school aged. All had been identified to the local school system and health care community. Ninety percent of the evaluations included the use of some form of voice output device aid that was easily demonstrated via the ICN Elmo system. Approximately 70% of all evaluations resulted in the local service providers securing a communication aid through the school system or the UHS team generating a prescription for funding of a trial or purchase of a device provided by parent's health insurance. Data collection during a trial period was sent via fax to the UHS team. Classroom observations of the client using a communication aid in the classroom setting were shared with the UHS team using the in studio VHS system. Because these evaluations typically rely on direct observations with a particular device this delivery system, telemedicine, does easily allow for initial evaluation as well as follow-up.

Limitations to telemedicine services for augmentative communication consultations include limited availability of needed devices for demonstration purposes, furthermore devices needed onsite modification (programming) which was not always feasible.

Since the inception of this grant the University Hospital School Augmentative/Alternative Communication Service and local service providers have worked more collaboratively for the betterment of individuals with developmental disabilities. All agree that this mode of delivery, telemedicine, is a viable mode for assessment and follow up for individuals who can benefit from assistive technology service to enhance the quality of their lives.
Please see Appendix A for the clinical protocol for Augmentative Communication Assessments.

Objective B: To determine best methods of protecting the confidentiality of patients with disabilities who are provided telemedicine care and services.

The procedures adopted to safeguard patient confidentiality accounted for increased risks associated with the requirement to share information among the various community care and service providers. These procedures also must recognize the variations in the regulations and operating procedures among the providers of care and services. Confidentiality for telemedicine consultation has become a major issue for patients and professionals. Concern for confidentially was addressed as follows and is noted below:

Access to Session – Iowa Cable Network - Iowa Communications Network

Arrangements were made with the ICN central operating staff in Johnston, Iowa, to "black-out" all viewing by audio/visual technicians. This was completed and verified at the beginning of telemedicine consultations.

The session was designed as a regular patient consultation and as such it was protected by the same patient information, privacy and confidentiality regulations as any visit to the University of Iowa Hospitals and Clinics. No entrance to the studios was permitted by people not authorized. Local community sites where surveyed prior to initiating consultations in all instances.

Participation in the evaluation/follow-up consultation was by the specific written agreement of patients. Standard patient participation and release information (see Appendix B) was completed and signed prior to a telemedicine consultation. Only approved participants were permitted to participate or view the consultation.

These procedures for confidentiality became part of the routine referral and consultation process. No problematical incidents occurred during the project. We continue to use the same procedures clinically at the present. Relevant procedures for local sites are also noted in Appendix C.

Forms to verify these confidentiality issues consist of: (1) Authorization of Patient Information, (2) Telemedicine Session Report, and (3) Videotape – Special Authorization of Video of Session, appear in Appendix B and D.

Clinical Arrangements and Consultation Scheduling for Telemedicine

The patient scheduling procedures for telemedicine are extremely important to the efficient and timely completion of consultations. We have adopted the basic philosophy that clinical scheduling should be identical to standard scheduling of patient evaluations and treatment. Clearly, each health center has its idiosyncratic and unique needs in this process but we offer the following specific guidelines and "flow" of this process to guide others. These procedures are applicable to all clinical protocols. The following comments are depicted graphically in Figure 1.

REFERRAL – Referrals generally begin with a determination by a local service provider that a patient can benefit by being seen for initial or follow-up consultation by University Hospital School staff via UHS Telemedicine Services. Local service providers or clinicians will then contact a UHS clinician, project community coordinator, and/or local cohort team member for consultation (see Telemedicine Assessment Request, in Appendix C).

CLINICAL CONSULTATION – A clinical consultation with a UHS cohort team leader or designate must occur for the process to continue. If UHS staff concur that a telemedicine Assessment is clinically viable and within the protocols of its cohort the team leader or designate consults with a telemedicine specialist concerning technical issues.

TECHNICAL CONSULTATION – A technical consultation with a UHS telemedicine specialist determines if the type of assessment required can be done at the proposed referral site or alternate site, within the project catchment area. A decision on whether or not the assessment can take place at the desired site(s) will be made based on how well the site addresses the technical and clinical protocols of the project. This is a key decision-making issue and requires some direct consultation between professionals. The details of the site are a key issue.

DECISION – If the decision is negative the telemedicine assessment process is terminated. If the decision is positive basic data gathering is begun by the telemedicine specialist.

DATA GATHERING – Basic data is collected from the team leader or designate by the telemedicine specialist on the: patient, ICN sites to be connected, clinical personnel to be assigned to both the assessment (UHS) and referral (the distant site), date and time desired for the assessment to take place, length of the assessment (i.e., one hour), and clinical and/or technical requirements or requests. With this information the telemedicine specialist can begin processing the Telemedicine Assessment Request form.

ASSESSMENT REQUEST FORM – The Telemedicine Assessment form is filled out by the telemedicine specialist and should include the following information (see Appendix B). This form includes: UHS staff making the request; patient information; location of assessment; type of assessment; assessment team at UHS by team members name and discipline; referral team information; clinical or technical needs as requested by the team leader or designate; and the time and date of the assessment and its length. Based on the information from this form ICN, UHS, and referral site scheduling can begin.

ICN SCHEDULING – The telemedicine specialist makes the request for an ICN session online and that request is forwarded (electronically) to the University Regional Scheduler (or the UIHC scheduler if using UIHC node) to IPTV/ICN scheduling and the appropriate scheduling authority at the referral site for approval. Confidentiality and privacy is confirmed at central site, Johnston, Iowa.

UHS SCHEDULING – UHS scheduling receives a copy of the Telemedicine Request form via e-mail and/or campus mail and proceeds following University Hospital School established guidelines. This appointment is scheduled as a normal clinic appointment for the necessary professional staff.

REFERRAL SITE SCHEDULING – The community coordinator receives a copy of the Telemedicine Request form via email and/or fax and proceeds with scheduling to insure that all parties involved at the referral site are contacted and advised of the date and time, site location, and length of the requested telemedicine session. This is done via letter, phone, or both depending on lead time prior to the actual assessment date and time and intake requirements.

REFERRAL SITE INTAKE – The community coordinator will handle all intake to include the following in all assessments: Authorization to Exchange Information form; Authorization to Obtain Information form; Information and Payment Request form; and Patient Information sheet.

Evaluation worksheets and/or re-evaluations worksheets are required for new patients or patients who have not been seen in the past 18 months.

All pre-service reports and other UHS/UIHC intake forms are completed if requested by the team leader or designate, these are standard clinical gathering information forms.

All participants in telemedicine assessments in the catchment area will be asked to sign a Certification of Subject Consent form and an Information Summary form. Signature of these two forms is optional as part of the evaluation component of the project. This form determines who will be in the confidential session.

All forms must be signed prior to the actual assessment of the patient. Intake forms should be forwarded to UHS as soon as possible following their completion.

ADJUSTMENTS – Resolutions of conflicts of time and date, location, personnel, equipment, etc. will be reported first to the telemedicine specialist and in consultation with team leaders, UHS and ICN scheduling, and the community coordinator, adjustments to the sessions made accordingly and all parties effected, notified.

ASSESSMENT – Prior to the actual assessments of the patient teams at both sites go through an introduction or roll call of those in attendance to confirm that all persons requested to attend are present, make note of and authorize the attendance of persons not previously invited. The telemedicine specialist and community coordinator monitor the sessions progress and supply technical assistance as required or requested.

SESSION RECORD KEEPING – At both the assessment site (UHS) and the referral site (distance site) a record is kept of all in attendance on a Telemedicine Session Report form. A copy of this form is kept by the community coordinator, the telemedicine specialist and the original was forwarded to economic analyst as part of the project evaluation component, this latter contact monitored economic data for the project.

Copies of signed Certification of Subject Consent and Information Summary forms are routed to the participant and the telemedicine specialist.

Any technical problems are noted by the local community coordinator and/or the telemedicine specialist and solutions sought as soon as possible.

REPORTS – Reports by UHS staff attending a telemedicine assessment should proceed following University Hospital School established guidelines. All clinical sessions are summarized using a standard clinical report format and filed in the patients UIHC medical record. Reports are completed within 72 hours and distributed to all recipients noted on the Authorization of Information form.

T he assessment and referral process used in this project has been successful in large measure because it follows and compliments the standard referral and assessment procedures designed by all professional clinicians and clinic administrators. We believe that the continued success of our now ongoing telemedicine service is related to its similarity to our general clinical work and its development by clinicians who have used the service on a regular basis.

Iowa Communications Network and Studio Hardware

History of the Iowa Communications Network

The Iowa Communications Network is a statewide, T3 fiber optic network with more than 3,000 miles of cable reaching into all 99 counties of Iowa. This network puts every Iowan within 15 miles of an accessible ICN site. The capacity of the ICN enables state and federal government, defense armories, libraries, K – 12 schools, public and private colleges and universities, and hospitals to communicate in real time via high quality, full-motion video and audio connections, see Appendix D.

Phase 1 construction began in 1991 and in early 1994, 49 sites were activated. The remaining 55 ICN sites included in Phase 1 were activated during the following fall and winter. Phases 2 and 3 have brought the current total of sites to more then 700. This significant number of sites greatly enhances our ability to provide telemedicine services as we can generally use the closest site to the consumers home to provide services.

Work on the University Hospital School ICN clinical studio was completed and the studio tested in March of 1996. The first ICN educational session occurred in April of 1996 and the first telemedicine session in November of that year.

Connectivity/Configuration

All ICN sessions are put together (electronically connected) at the ICN network hub located in Johnston, Iowa. Scheduled requests, regardless of the number of sites, are "patched" together at the appropriate time so the sessions can occur. Normally, the technical staff there monitors video/audio and data quality for all ICN sessions.

The signals are routed to the appropriate site, which then codes and decodes transmissions and receptions. Typically, each ICN site maintains one node capable of coding and decoding. In the case of the University of Iowa, a series of five nodes are maintained at the University of Iowa Broadcast Services. All ICN sites on campus (including UHS) share these nodes. There are currently more than a dozen UI sites. While this is fiscally sound due to the cost of each node, it adds an additional scheduling layer to an already complex scheduling system. Additionally, our transceiving ability was "at-risk" if any problems surfaced at Broadcast Services, with our connection to them, the trunk line, or if there was not a node available at the appropriate time. Approximately one year into the project we were notified that Broadcast Services would be moved and all five nodes would be out of service during the move. We requested a connection to a node owned and operated by the University of Iowa Hospitals and Clinics which was approved. The second connection allowed us to continue providing telemedicine services during the UI outage, plus it continues to provide us with redundancy of service in case or problems on either side of campus.

As mentioned earlier the ICN system is a T3 fiber optic network capable of delivering real time full motion video. Audio configuration however has some limitations. With the exception of "instructor microphones" at site originating the session, audio is transmitted via push to talk microphones. Therefore only one participant at any given time may speak.

Confidentiality

Telemedicine sessions conducted over the ICN are scheduled as confidential sessions as a matter of UHS SOP. A confidential designation at the ICN Hub means that the session is not monitored, as would be the case with other ICN events. Additionally the sessions are electronically routed so that no other sites other that those scheduled can view the session.

Due to the University of Iowa's decision to share nodes, it was discovered that any ICN site on campus could "tune in" to a confidential telemedicine session. To address this issue a signal scrambler was installed at UI Broadcast Services and a de-scrambler was installed at the UHS site. This device makes the confidential signal viewable only to the UHS clinical studio and no other campus site. The UI Broadcast Services technical staffs are subject to the same protocols for non-monitoring during confidential sessions as the technical staff at the ICN hub. All UIHC employees, including those at the signal routing point, are subject to patient confidentiality rules and regulations so the need for scrambling this signal is not as significant.

The local community personnel maintains confidentiality at community sites. Each site is tested and checked prior to scheduling a session. As part of the site test, issues that could effect confidentiality are noted and plans for addressing those issues discussed. As an example, several sites were found to have windows that would allow a public view of the studio. In each case arrangements were made to cover the windows so that confidentiality could be maintained. In all cases, personnel associated with each site were made aware of the session(s) and appropriate signage deployed to insure confidentiality.

Confidentiality at the University Hospital School Clinical Studio is maintained by UHS and UIHC patient confidentiality polices and procedures. Additionally, appropriate signage is placed indicating that a confidential session is underway.

Clinical Studio Equipment Configuration

The original equipment configuration of the UHS Clinical Studio consisted of the following:

- One instructor console containing a VCR for tape playback, and overhead display unit for projecting printed materials or transparencies, a slide projector, 3 lavaliere microphones and mixer, a push to talk microphone, fax machine and various preview and video output monitors.
- Two Sony large screen monitors on roll about carts. One located at the rear of the room set to display incoming video from the community site and the other located at the front of the room in proximity to the instructor console to display either incoming video from the community site or outgoing video from the UHS site.
- One fixed position clinician/student camera ceiling mounted offering a view of the entire general seating area of the studio with limited zoom capability.
- One fixed position wall mounted robotic instructor camera offering a view of the instructor/presenter with zoom, pan/tilt, focus capability. Additionally, this camera can be configured to work with a remote sensing device which allows the camera to "follow" a presenter as he/she moved about the studio.
- One tripod mounted moveable camera for use with demonstrations or presentations requiring more flexibility than provided by either the clinician/student or instructor cameras.
- Eight push to talk microphones all located in the general seating area.
- One touch-screen computer for selection of studio video and audio sources to be displayed and for selection of community sites to be viewed.

Equipment Additions

The following equipment has been added to the UHS clinical studio to meet identified shortfalls during this project:

- A third large screen monitor on a roll about cart to allow clinicians in the UHS studio to view incoming and outgoing signals without turning their back to the camera thus maintaining eye contact with the community site participants. This proved very useful when:
- demonstrating types and operations of particular devices (Aug Com/BBS)
- demonstrating recommended behavior modification techniques or devices (BBS)
- demonstrating recommended types and operations of feeding devices (Feeding Team)
- sharing hard copy clinical data via over head projector and or computer

- Replacement of clinician camera with a robotic ceiling mounted camera. This camera was strategically placed next to the incoming video large screen monitor to:
- better identify which UHS clinician is speaking when addressing a given issue, recommendation, or goal during and evaluation
- establish and maintain eye contact between the speakers. UHS participants viewing incoming video and speaking are looking directly at both the incoming video and the camera sending the outgoing video to community sites.
- Video Pointer
- An electronic character-generating device located at the instructor console, capable of placing a "pointer" (left/right arrow, circle/square or crosshairs) over playback of videotape. Clinicians at the community site suggested that seeing in real time rather hearing or reading about results of video taped radiological swallow studies (Feeding Team) are useful in
- understanding the feeding and swallowing issues under discussion
- the recommendations of the UHS team based on the results of the radiological swallow study

Equipment Considered but Not Added

- AMD Ausculette electronic stethoscope – as a result of a need expressed by members of the UHS Feeding Team, representatives of NEC assessed if and how the UHS clinical studio in conjunction with community sites can effectively utilize an AMD Ausculette electronic stethoscope over the T3 (ICN). This technology over an ISDN was previewed by a team member and found to be very helpful in assessing a patient's swallowing function. The final determination from the NEC engineers was that UHS would need to purchase additional codec equipment for both the sending and receiving site at an estimated cost of over $35,000. It was determined that the technology was not critical in the accomplishment of the team's protocols.

Evaluation

Originally we perceived UHS as being the only originating site with the Ottumwa sites acting a remote or receive site. This was based on the assumption that UHS would be doing most of the presenting during the evaluations or consultations and there from would need to be the originator to allow clinicians in the Clinical Studio freedom from push to talk mikes. It became apparent that in most cases the remote site needed the "hands free" that an originating site provides and technical protocols were adjusted accordingly.

It was also thought that we would be limited to two sites, one originator and one remote. This based on the technical setup of the ICN hub at the time. At that time to insure confidentiality, only two sites per session could be electronically blocked from general view using a hard wire patch. As the ICN hub continued to update its equipment it became possible to accomplish total confidentiality for any number of sites in a given session. This allowed us to connect as many as 4 sites in a session allowing clinicians across a wide area of the catchment access to the evaluation.

Initially it was presumed that all evaluations across all cohorts would need to be scheduled in one hour to on and one half-hour blocks. However as the project progressed it became apparent that the teams could as a rule accomplish their goals for the evaluations in less time. The average running time now is approximately or 45 minutes.

Use of the tripod-mounted "handheld" camera was thought to be of limited value at first based in part on the previously mentioned belief that telemedicine session would be conducted along the same esthetic and production value lines as other ICN sessions. As team members became more comfortable with the ICN, how it worked, and what it could do they became more assertive in their presentation efforts particularly when showing behavior modification and feeding techniques.

Phase II – Evaluation

After the piloting and refining of the telemedicine procedures and ongoing consultation with local professionals and consumers we began Phase II to offer services and begin ongoing evaluation of these services. The following sections describe our samples and our clinical/research interviews to evaluate our efforts.

Treatment Sample

The study treatment sample was obtained as a convenience sample based upon local need and referral from the designated catchment area. The catchment area was selected as a rural and distant location (approximately 90 miles) from University Hospital School in Iowa City, Iowa, as the focus of the initial telemedicine proposal. The Area Education Agency 15 (a large administrative multi-county unit serving 3,575 children with disabilities) and the Ottumwa Regional Health Center serve as the target sites and provide services for approximately 70,000 predominantly rural residents in southeastern Iowa.

Four cohorts of children with specific pre-selected disabilities were included: (1) children with disabilities who have unmet health care needs, children with neuromuscular disorders and acquired brain injury, (2) children with developmental disorders and severe behavior disorders, (3) children with swallowing disorders, and (4) children who because of their disabilities have a need for assistive technology and/or augmentative communication assistance.

Study subjects in the treatment group consisted primarily of *parents* of the children with disabilities and *professionals* providing services to these children in their respective rural community areas. Specific numbers of these families are noted in Table 1. The final treatment sample consisted of 55 families and 135 providers. Over 100 families and children were enrolled.

Control Sample

Controls consisted of two sample types, (1) families who had a child with disabilities and had a prior (non-telemedicine) contact with the University Hospital School and (2) local providers who did not participate in this telemedicine project but who also had prior contact with the University Hospital School in referring specific patients. The family controls were selected on the basis of child problem and similar socio-economic circumstances and outside the research catchment area. Although an attempt was made to match for both child problem and severity of disabilities this proved formidable and generally unsuccessful. Controls were defined as parents who had prior contact (treatment/evaluation) with the University Hospital School but no telemedicine experience. Professional controls were defined as those professionals (all types) who had made referrals to the University Hospital School previously, outside of the research catchment area, and have received consultation/evaluation reports on these patients and families.

Subject participation (patients and professional providers) is outlined in the following Table 1:

Table 1
SUBJECT PARTICIPATION

	Family/Catchment	Family/Control	Provider/Catchment	Provider/Control	Totals
# Complete	55	50	135	36	273
# Callbacks	7	4	29	7	47
Not Eligible		2	2	0	4
Problem #	4	5	5	1	15
Refusal 1		0		1	2
Duplicate 2		2	0		2
Late Enroll	7		21	0	28
Totals	73	64	192	45	371

Family and Provider Interviews of Telemedicine and Control Data

The Iowa Institute for Social Sciences is an independent social science service consulting unit located on the University of Iowa campus. This independent research institute has a history for excellence in evaluating research studies. This institute was contacted to assist with the development and direct interviewing of all families and providers. The institute provided direct phone-based interviews (15 to 30 minutes in length) of all families and professionals involved in this study. A detailed interview protocol was designed and formed the basis for the telephone interview of all families/providers (treatment and control) who agreed to participate in the interview. A detailed interview protocol for families and providers is included in Appendix E. This protocol was designed to evaluate the objectives of this project.

Explanation of Subject Participation

Family Catchment: families in the treatment area who received telemedicine consultation
Family Control: families who did not receive consultation from telemedicine but did receive prior onsite services from UHS
Provider Catchment: professionals in the treatment area who referred telemedicine patients in the current study
Provider Control: professionals who did not receive telemedicine consultations but did have prior consultation contacts with University Hospital School
Complete: completed phone interviews
Callbacks: repeated tries to reach with no success

Not Eligible:	did not meet study criteria
Problems:	variety of concerns, unable to reach, incomplete, etc.
Referral:	refused to participate
Duplicate:	repeated contacts in study group
Late Enrollment:	recontacted after study date concluded.

Research Analyses and Data Preparation

The entire data file was inspected multiple times and reviewed for missing and erroneous values by staff of the Iowa Institute for Social Sciences. Descriptive data frequencies were tabulated for each group (Family Catchment, Family Control, Provider Catchment, Provider Control).

One hundred (100) subjects (patients/families) were enrolled, and 73 families agreed to participate in the final interviews for a participation rate of 73 percent. Complete data were available on 55 patient families. The control groups (Family Control) consisted of 64 families, 50 of which completed these interviews for a participation rate of 78 percent.

Providers in the catchment (research-treatment) area consisted of 135 individuals (physicians 4, nurse 4, social work 10, educational specialist – psychologist, speech pathologist, educational consultant 33, and other – teachers and service providers, 84. Of the 192 available, 135 participated for a 71 percent participation rate. Finally, provider controls consisted of 36 individuals (physicians 4, nurse 2, educational specialty – psychologist, speech pathologist, educational consultant 4, and other – teachers and service providers, 26. Of the 45 contacted, 36 agreed to interview for a participation rate of 80 percent. This group (Provider Control) was the most difficult to recruit and obtain. We expended considerable time on physician recruitment but with little result. We suspect most felt a limited basis for participating.

Research analyses were completed with consultation and analyses from the Biostatistical Consulting Center of the University of Iowa. Data analyses were determined and executed by doctoral level professional statisticians. The data was reviewed and presented in descriptive formats. All analyses were completed by contrasting matching groups (Treatment vs. Control) using two statistical tests: Fisher's Exact Test, Wilcoxon Rank Sum Test. Significance levels were set at $p=\leq .05$ in all instances.

Introduction to Statistical Comparisons

The following statistical comparisons and conclusions are based upon a detailed interview identified by Question (interview) number and found in the Appendix E. ALL data tables are located in Appendix F and G and are keyed by question. To examine specific data outcomes it is suggested you review each question in conjunction with its tabled data analyses. The following analysis presents the majority of major questions and analyses, however this presentation is a selected analyses. All tested variables are referred by question number, i.e., Q1, etc.

<u>Telemedicine Patient versus Control Group</u>

Comparison of the Telemedicine Patient (Families) and Control (Families) Group did not reveal any significant difference on the following variables:

- Child's health/behavioral condition
- Distance and travel time to the Health Center
- Parent attending consultations
- Age of child in consultation
- Parent employment and educational status
- Age and Race of Parents
- Income of Parents
- Gender of Respondents

These foregoing comparisons <u>suggest</u> that the Telemedicine Patient and the <u>patient control groups are comparable</u>.

The following differences were noted to be statistically different between the Telemedicine Patient and the Control Patient groups:

- Differences in visitation frequency to the UHS
- Timed missed from work (in Favor of Telemedicine) Q18, $p = .02$

The following comparisons suggest that there are <u>no statistical differences between the Telemedicine Patient and Control Patient Groups</u>:

- Satisfaction with most current visit
- Rated quality of care at recent visit
- Time spent with physicians and professionals
- Ease of appointment making
- Rated quality of professional concern

These aforementioned comparisons <u>suggest</u> that there are <u>no differences</u> reported by patients (parents) between telemedicine contact versus the Control patients (parents). The quality of the evaluations completed via telemedicine considering <u>quality of care</u>, physician and professional time, ease of appointment making and perceived physician and professional care <u>is rated as good as face to face direct clinical consultation</u>.

A <u>within group</u> (Telemedicine Patients) analyses revealed no significant differences on the following:

- Recent quality of onsite consultation <u>versus</u> telemedicine consultation
- Amount of <u>time</u> during onsite consultation with all professionals <u>versus</u> telemedicine consultation
- Ease of <u>appointment</u> making regular visit <u>versus</u> telemedicine consultation
- Rated <u>provider concern</u> of onsite consultation <u>versus</u> telemedicine consultation

These within group (pre and post) comparisons (i.e., parent's reporting their experience with prior face to face consultation with telemedicine consultation) are all rated very positively by parents completing the telemedicine consultations and as good as their own previous experience with face to face direct consultation with the University Hospital School professionals.

Attitudes of Telemedicine Group Reported toward Telemedicine Consultation Experience

Parents in the Telemedicine Groups rated the following:
- Current view of telemedicine experience, 98 percent (54/55) the same or more positive.
- Quality of care of the telemedicine experience, 98 percent (54/55) Good to Excellent
- Current quality of provider concern during telemedicine consultation, 98 percent (54/55) Good to Excellent
- Following telemedicine consultation, 98 percent (54/55) were satisfied to very satisfied
- Parents evaluation of the technical aspects of telemedicine consultation

During consultation between 8 and 12 percent of parents noted some difficulty with being able to communicate, hearing others, and seeing others. Nevertheless, the overwhelming (90 percent) of participants reported no difficulties in these areas.

Concerns in these areas reflect

- Poor volume of participants
- Improper microphone location
- Periodic movement of cameras
- Improper camera locations
- Studio (offsite) audio concerns

Telemedicine Provider versus Control Group

Statistical comparisons to evaluate the comparability of the Telemedicine Provider versus Control Group Comparison of the Telemedicine Provider and Control Group did not reveal any significant differences on the following:

- Time spent in actual consultation
- Distance from office to telemedicine site
- Times referred patients
- Ease of appointment making

The aforementioned comparisons suggest that the Telemedicine Provider and the Control Provider groups are comparable. It should be noted that because of the unequal numbers of subjects (provider type) between the Telemedicine Provider and Provider Controls these groups on this feature (provider) are not identical, however, interpretation is not significantly affected.

The following comparisons suggest that there are no statistical differences between the Telemedicine Provider and Provider Control Groups:

- Rated satisfaction of most recent consultation (telemedicine vs onsite)
- Rated quality of care received at the University Hospital School
- Amount of time for consultations with professionals
- Rated provider concern
- Satisfaction with referral relations

These aforementioned comparisons suggest that there are no differences reported by providers (professionals) between the telemedicine consultation versus the face to face consultation considering rated satisfaction, quality of care received, amount of time with professionals, provider concern and satisfaction with referral procedures. This suggests that the telemedicine consultations are as "good" as onsite face to face consultations.

<u>Comparison of Attitudes Among Providers on their Satisfaction with the Telemedicine Consultation</u>

Question number 35 asked the respondents "Thinking about your most recent telemedicine experience, on a scale of 1 to 5 where 1 is strongly disagree and 5 is strongly agree, please tell me how much you agree or disagree with each of the following statements." Q35 "The consultation would have been better if it had been conducted in person."

The following distribution resulted:	N	%
1 strongly disagree	36	26.8
2	30	22.3
3	27	20.1
4	24	17.9
5 strongly agree	17	12.6
Total	134	100

We developed two groups from the response to the question:
1 and 2 disagree, N=66, In Favor of Telemedicine <u>and</u> 4 and 5 agree, N=41 In Favor of in person consultation

We then contrasted (on the basis of this dichotomy – favor/not in favor) the sample responses based upon these two "new groups." Significant differences in relation to this experimental dichotomy revealed the following findings. All comparisons were significant at .05 or greater.

Those <u>In Favor</u> of Telemedicine for Consultation:
- Viewed appointments making as more positive
- Participated more often in telemedicine consultations
- Viewed access to high quality care as an important issue
- Viewed telemedicine more positive with increasing contact experience
- Reported that families are more positive about telemedicine than onsite
- Providers are comfortable with telemedicine
- Providers report more communication is permitted

- Providers report they see this as providing better care
- Providers report more positive since it permits productive use of time
- Those who have received more training are more positive
- Providers report it made it easier to provide care
- Providers who are more positive more often recommend this service

These aforementioned comments suggest that those who report that telemedicine as more favorable see it as providing access to higher quality care, receive positive feedback from patients, tend to have higher participation rates in telemedicine consultations, and see it as a productive use of their professional time.

<u>Attitudes of Telemedicine Provider Group Reported toward Telemedicine Consultation Experience</u>

Providers in the telemedicine group rated the following:

- Access to high quality care as a factor or major factor in use, 88 percent 97/111
- Use because of family finances as a factor or major factor, 53 percent 52/98
- Use because of time savings is a factor or major factor, 96 percent 105/110
- Use because it provided better care agree to strongly agree, 81 percent 106/131

<u>Provider Evaluation of the Technical Aspects of Telemedicine Consultation</u>

During consultation between 8 and 12 percent of providers noted some difficulty with being able to communicate, hearing others, and see others. Nevertheless, the overwhelming (88 percent) of participants reported no difficulties in these areas. Concerns in these areas reflect:

- More positive experience with more training
- Poor volume of participants
- Improper microphone location
- Periodic movement of cameras
- Improper camera locations
- Studio problems – all types

<u>Economic Analyses</u>

The objective of this section is to assess the economic consequences of this telemedicine-based initiative in terms of its potential to reduce transportation costs and lower the time-costs associated with travel to provide care for children with disabilities and the local providers.

Two primary hypotheses underlie the UHS project: that telemedicine-based consultations in these pediatric populations are feasible and that they reduce the amount of time and transportation required for consultations.

Travel Costs

Travel costs were estimated by calculating the distance and expected amount of time spent traveling between Iowa City and the referral community and then estimating the transportation cost and opportunity cost of time spent in transit. By estimating the travel and time costs that would have occurred in the absence of this telemedicine-based initiative, we are able to estimate the potential savings in these costs attributable to this approach. These costs involve cost of transportation and professional costs to participate in this consultation if it were held on-site in Iowa City at University Hospital School.

Time Costs

Estimation of time costs proved a difficult task given the large number of occupations represented in the sessions. The basic approach involved estimating the amount of time individuals would have spent traveling between the referral site and Iowa City and valuing this time based on the individual's estimated hourly compensation.

Hourly Compensation Estimates

Session participants were not asked to report their earnings given concern that doing so might lessen response rates. Moreover, the nationally representative compensation estimates we used enhance the generalizability of our estimates beyond Iowa. To ensure consistency in earnings estimates across occupational groups, we relied heavily on the US Bureau of Labor Statistics estimates of hourly and annual mean wages by occupation (Table 3). Because these wages exclude employee benefits, we adjusted these mean wage estimates to account for an average benefit of 17% as recommended by the Centers for Disease Control for economic evaluation in health care. All earnings estimates were adjusted to July 1999 dollars based on the Consumer Price Index – All Urban Consumers[1].

To estimate earnings for family members and others for who occupation data were not available, we used the median annual earnings for full-year, full-time workers; aged 35 to 44 published by the US Bureau of the Census[2] (adjusted to 1999). Students, the children being evaluated, and siblings were excluded from the analyses.

Mileage Costs

To estimate mileage costs, we assumed an average of three people per car would make the trip. We used the US Internal Revenue Service 1998 mileage allowance of $ .325 per mile to estimate transportation costs.

Data were obtained on a total of <u>91 sessions</u> over the period February 24 1998 to July 8, 1999. Eight sessions, occurring primarily in the first four months of the evaluation could not be evaluated because of incomplete data resulting in <u>83 evaluable cases</u>.

Characteristics of sessions

Characteristics of the evaluable sessions are summarized in Table 4. Half of the sessions involved children with behavior disorders. Assistive technology and swallowing disorders each accounted for approximately 20% of the sessions. Five sessions involved health concerns. One session involved the assessment of a child for both swallowing disorder and behavior disorder. Even though this session involved two separate assessments (a one hour swallowing disorder assessment and a 30-minute behavior disorder assessment), it was treated as a single session for analysis purposes.

The mean duration of the sessions was 51 minutes. Most of the sessions were either 30 or 60 minutes in duration.

The referral sites averaged slightly more than 2 more participants (excluding the client and students) per session than the UHS site. In addition to at least one parent or relative, a typical session included one or more educator, case or program manager, and health professionals (Table 5). Psychologists, speech-language pathologists, social workers, nurse practitioners, nutritionists, occupational and physical therapists were the most common participants at the UHS site (Table 6).

Participants at the referral sites reported a mean time spent traveling to and from the referral site of 16 minutes. Participants at the UHS site either reported no time in travel to the site or left the total travel time blank. Since most, if not all of the participants at the UHS site worked at the University Hospital School or the adjacent University of Iowa Hospitals and Clinics, it was assumed participants who did left this question blank did not have to travel to the UHS assessment site.

Distance between referral sites and Iowa City

The 83 sessions involved referral sites in 11 different cities (Table 7). Referrals from Ottumwa, Iowa, accounted for the majority of all referrals (53). The mean (weighted by the number of sessions in each location) travel distance between referral cities and Iowa City was 96.6 miles.

Travel-related Cost Savings

The estimated transportation savings in time spent in travel to Iowa City, assuming car pooling with three people per car is $141 (s.d. 72.6) per session. Based on an assumed average speed of 40 miles per hour, it was estimated that travel to and from Iowa City would have involved a mean of 4.8 hours per person per session. Applying the wage rates from Table 3 for each session, the estimated professional time cost saved by the telemedicine session is $830 (s.d. 1,339). The large standard deviation for time cost savings reflects the skewed nature of the estimate time cost savings distribution (Figure 2). The median time cost is $595.

Total cost savings attributable to the telemedicine sessions is the sum of the transportation savings and time cost savings, $971 per session. <u>These savings are to the local AEA Education Agency per child</u>. <u>This is, these savings are directed to local and state of Iowa families</u>. In essence, as of this writing 2/2000 based upon these calculated data fees and the currently number of telemedicine consultation to date is 178 suggesting that local districts and the state of Iowa have saved -- 178 x $971 = $172,838 based upon these calculations).

Discussion

We estimate that a single telemedicine session between the University Hospital School and an outlying referral site may result in a nearly $1,000 reduction in travel-related costs. Most of these potential savings arise because of the reduced time spent travelling between referral sites and Iowa City. We note that the true test of this program involves comparing these potential savings with the costs associated with initiating and maintaining the telemedicine service. A formal breakeven analysis would permit identification of the volume necessary to cover the initial investment and operating costs. For example, with a $30,000 initial investment (assuming a three-year effective economic life for the hardware and $150 operating costs per session), it would require only 12 sessions per year to "break even." Of course, the fact that the savings are realized by the child's family and providers and not by the University Hospital School may limit further development of development of telemedicine services somewhat.

These estimates reflect a number of simplifying assumptions. First, we have assumed that the number of participants would be the same with or without telemedicine. This seems unlikely. However, important to assume that the nature of the consultation sessions is the same under both scenarios in order to make for valid comparisons. It seems likely that fewer people would have participated if everyone had to travel to Iowa City. If so, however, then the very nature of the consultation has changed and it may not be appropriate to compare with the telemedicine interaction. By assuming the number of participants remains the same, we hold the nature of the session constant. Alternatively, one may argue that fewer participants reduce the quality of the assessment.

Table 3. Earnings Estimates Used to Calculate Time Costs by Occupation

Occupation	Mean Hourly Wage 1997	Benefits Adjustment	Adjust to 1999 Prices	
Physicians	48.52	56.77	58.96	
Psychologists	23.78	27.82	28.90	
Registered Nurses	19.91	23.29	24.19	
Speech-Language Pathologists	21.33	24.96	25.92	
Occupational Therapists	24.33	28.47	29.57	
Physical Therapists	26.95	31.53	32.75	
Physician Assistants	21.63	25.31	26.28	
Dietiticians/Nutritionists	16.41	19.20	19.94	
All Other Health professionals	14.81	17.33	18.00	
Social Workers	15.82	18.51	19.22	
Education Administrators	26.87	31.44	32.65	
Teachers	26.74	31.29	32.50	
Teacher Aides	7.96	9.31	9.67	
Median earnings, full time workers	14.10	16.49	17.13	

Table 4. Earnings Estimates Used to Calculate Time Costs by Occupation

EVALUATION TYPE	n	%
Assistive Technology	17	20.5
Behavior Disorder	42	50.6
Health Concerns	5	6.0
Swallowing Disorder	18	21.7
Multiple Disorders	1	1.2
Session Duration		
Mean (minutes)	50.8	
Standard Deviation	16.2	

MEAN NUMBER OF SESSION PARTICIPANTS (EXCLUDING CLIENT AND STUDENTS)

Referral Sites	5.9
UHS Site	3.6

TABLE 5. PERSONS PARTICIPATING AT REFERRAL SITES

	Number of times represented	
Relatives and friends of client		94
Mother or father	81	
Friend or other relative	13	

Educators		103
Teacher	57	
ECSE	8	
Teacher/health aide	18	
Principal/Assistant Principal	17	
Miscellaneous education	3	
Case/Program Managers		129
First Resources	30	
Case Manager	19	
Program Manager	14	
CHSC	15	
Consultant	12	
Miscellaneous agency representatives	121	
Healthcare Professionals		145
Speech/Language	35	
Occupational Therapists	22	
Physicians	19	
Social Workers	13	
Pediatric Nurse Practitioners	11	
Psychologists	11	
Physical Therapists	11	
Respite Care	11	
Miscellaneous health care participants	21	
Student Participants		5
Miscellaneous Participants		10
Participant function Unknown		6
Total number of participants		492

Table 6. Persons Participating at UHS Site

Profession		
Healthcare professionals		286
Psychologist	87	
Speech/Language/Path	57	
Social Worker	31	
Nurse practitioner/pediatric nurse practitioner	21	
Nutritionist	14	
Occupational Therapist	12	
Educational consultant	10	
COTA	9	
Physical Therapy	6	
Physician	6	
Consultant	4	
Registered Nurse	2	
Other	27	
Students		15
Participant function Unknown		6
Total number of participants		307

Table 7. Driving Distance Between Referral City and Iowa City

Referral Site	Number of Sessions	Miles to Iowa City
Albia IHC	1	121
Cardinal High School (Eldon)	1	92
Centerville High School	3	141
Corydon IHCC	1	213
Fairfield	11	73
Fremont	1	104
Keosauqua	5	87
Moravia Elementary	1	137
Oskaloosa	5	92
Ottumwa (multiple sites)	53	98
Sigourney	1	115

Conclusions and Discussion

Phase I. Development of Telemedicine Procedures

The project was designed to test the potential of the Iowa Communications Network to assist the UHS to provide selected tertiary services in an effective manner for patients, families, community care and service providers. The existing Iowa fiber-optic network was used in the process.

During Phase I the UHS staff developed and refined the telemedicine protocols and procedures in consultation with local providers. Local collaboration during development was a key factor in success. Procedures were defined and developed to be easily integrated into the existing clinical service routines. Four clinical care teams developed relevant protocols and procedures which were refined throughout the grant period. Procedures for maintaining confidentiality and clinical scheduling were developed, Appendix B and D. It was important to have all procedures consistent with existing scheduling and evaluation procedures. A local off-site referral coordinator developed and refined local procedures among families, patients, and multiple professional agencies, Appendix C. This local coordinator was a key success factor in the efficient scheduling and running of all telemedicine consultations. Specific scheduling and consultation procedures were organized and have become instrumental in the ongoing life of the telemedicine service following grant completion A detailed scheduling/consultation set of procedures is now part of the ongoing training of new professionals and potential new service sites. These procedures noted many guidelines based upon direct experiences, and such training will become part of the UHS ongoing telemedicine service (see Appendix B and C).

Phase I has been successful in designing and developing practical procedures for clinical evaluations, coordination procedures for local providers and families, and tailoring these procedures to coincide with the existing clinical service system of University Hospital School and UIHC.

The four (4) clinical care teams that were offered each developed a research service program and a particular telemedicine protocol. Two types of care were provided:

- Providing initial, specialized interdisciplinary consultations by UHS staff in conjunction with local care and service providers, professionals, and families.
- Providing follow-up evaluations subsequent to the initial evaluations, either completed via the ICN or onsite at UHS.

UHS clinical teams offered the following suggestions and conclusions:
The vast majority of consultations (75%) completed consisted of follow-up consultations, after an initial evaluation was completed onsite at UHS were the patient and family attended and in some cases local off-site professionals.

All clinical care teams found that the telemedicine format was very well suited to follow-up consultation for children with chronic health and developmental disabilities. Caregivers and providers agreed with this conclusion based upon the interviews and data noted earlier in this report.

Initial evaluations were completed by all clinical care teams. The use of telemedicine for initial evaluations were affected by a variety of issues noted during the deviation of the research project.

The following issues are important factors in completing initial evaluations on children with specialized health and behavioral considerations:

- The need for awareness of skills in specialized clinical and diagnostic assessments.
- The need for specialized devices (hardware) for evaluation (oximeter [oxygen saturation device]) and their use (augmentative communication hardware) during consultation.
- Pre-training of specialized procedures and use of clinical devices.
- Care Team Conclusions by Area

The following section reviews specific comments from each clinical care team on the clinical evaluation and follow-up procedures. These comments were generated from a specific review with each care team leader and the entire team of professionals.

<u>Children with Special Health Care Needs</u>

Acquired Brain Injury / Neuromuscular Disorders

This care team noted as important:

- Pre-planning with the local physician or nurse staff
- Local telemedicine coordinator is needed
- Define the clinical examination and specific questions ahead of time
- Pre-training on the brain injury screening protocol
- Currently the clinical examination is most useful for pre-screening brain injury evaluations
- Currently follow-up evaluation is very easily accomplished

- Direct physical (neuromuscular) examination is possible with guidance of UHS physician and local off-site nurse completing exam and reporting

Children with Severe Behavior Disorders

The care team noted as important:

- Pre-planning with local caregivers and providers reviewing the agreed upon protocol-trained local staff are needed for evaluations
- Direct "coaching" of behavioral evaluation and behavioral treatments is completed and has been very successful during initial or follow-up consultations
- Initial screening of behavioral functioning has been very successful and the most frequent type of initial examinations by the team
- Children with Swallowing Disorders
- The care team noted as important:
- Pre-planning with the local caregivers and providers reviewing the agreed upon protocol
- Review of specialized evaluations (video of swallowing) is possible and very beneficial for consultation for all to view
- Oximeter is needed and easily used by key local providers during the evaluation

Children Needing Assistive Technology
Children with Neuromuscular Involvement of Speech Mechanisms
Children with Neuromuscular Disorders

This team provided consultation for the evaluation and use of assistive technology and the care team noted as important:

- Pre-planning with the local care givers and providers reviewing the agreed upon protocol.
- Classroom observations (remote-wireless) video (real time) permitted actual use of devices and was extremely helpful
- Successful evaluations (initial) related to the availability of specialized devices and their use by caregivers locally
- Close up of the camera on facial movements was very beneficial
- Pre-evaluation screening of patients (positioning) for specialized assessment (mobility evaluation, special seating, electric wheelchairs, etc.) is possible prior to onsite (UHS) final fitting and construction for the patient.
- ALL CARE TEAMS AFFIRMED THE IMPORTANCE OF THE FOLLOWING:
- Pre-planning of consultation – have an agenda
- Active involvement of local professionals during the consultation promotes learning and acceptance
- Active involvement of parents with the child
- Designation of team leader (for discussion purposes), at both sites
- Summarization of finding and interactive discussion of recommendations at the conclusion is a key factor in success

Phase II: Evaluation – What is the satisfaction and reported effectiveness of providing telemedicine consultations to children and families in a rural state in the view of families and providers?

This section provides a list of summative conclusions based upon the data analyses presented earlier in this report. These conclusions are based upon the interview completed by the Iowa Social Science Institute (see Appendix E) and subsequent analyses assisted by the Biostatistical Consultation Service of the University of Iowa. Details on the analyses are noted earlier, and the complete data set for all groups is in the appendices (Appendix F and G). Economic analyses were completed and presented by consultant Thomas Taylor.

Parent Evaluation of Telemedicine

Parents as consumers report a very high degree of satisfaction (98% - satisfied to very satisfied) with virtually all aspects of services provided by the care teams. These positive evaluations include the quality of care provided, time with health care providers, reported positive attitudes of the health care providers, and increased positive regard for the continued use of telemedicine procedures. Parents as consumers report that they are as positively satisfied (satisfied to very satisfied) with telemedicine consultations as they are with face to face direct evaluations provided.

Provider Evaluation of Telemedicine

Providers (physicians, nurses, social workers, educational/psychological specialist, and teachers, and service providers) report that the telemedicine consultation provided access to high quality care (88%), was viewed as a time saver (96%) and provided better care (81%). Providers who were in favor of using telemedicine consultation had more ongoing contact with telemedicine, reported that families where very positive toward consultations, and reported more communication was permitted by telemedicine consultation.

Providers (physicians, nurses, social workers, educational/psychological specialists, and teachers, and service providers) reported that telemedicine consultation was as good as face-to-face direct consultation for the majority (question 35 – Provider) 69% (93/134) of consultations offered. Those providers who report telemedicine as a more favorable consultation see it as providing access to higher quality care, receive positive and regular feedback from patients, tend to have higher participation rates in telemedicine consultations and view this type of consultation as a productive use their time.

Economic Analyses

The economic analyses were detailed earlier. The analyses suggest the following conclusions. Assumptions underlying these comments are detailed earlier in the section on Economic Analyses. Telemedicine is a major cost saver to local families and local professionals. The average saving to the local district and the state of Iowa was $971.00 per telemedicine session for a dramatic cost saving to local families and professionals.

Major Accomplishments Completed by the Faculty and Staff of University Hospital School

This project was initiated based on the assumption that we could provide more efficient and comprehensive evaluations and treatment to children and families with special health and developmental needs in rural Iowa. We recognized a need to collaboratively develop specialized services in rural locations based upon consumer and professionals requests (Hoyt, D.R. and Mack, K.Y., 1996) in a comprehensive needs assessment survey. This project was successfully accomplished because of the expertise and caring of over 50 professionals (Appendix H) at UHS, Southern Prairie Area Education Agency professionals in Ottumwa, Iowa, the health care staff at the Ottumwa Regional Health Center, and the professionals of the Regional Child Health Specialty Clinics in Ottumwa. *As a group we learned that we could do more and provide more, if we worked together in a collaborative fashion.* The telemedicine project provided the opportunity to share expertise and learn from each other. This project is no longer viewed as a research and development effort by all but part of the needed services in Iowa's health care in the coming decades. Many participants; caregivers, parents, providers, recognize that technology is important and vital to health care in rural Iowa. We have an obligation to continue and refine these services.

The Following Highlight the Major Accomplishments of this Project

- Parents become care managers during participation in telemedicine
- Recommendations for treatment are presented and discussed in 'real time' promoting efficiency, coordination, direct practical applicability for the patient and more immediate implementation
- Follow-up can occur more frequently and in a more timely manner for families and patients
- Increased professional collaboration and rapport is possible and a major benefit
- Major savings occurs for families in out of pocket costs by staying in the community
- Parents-consumers report very high satisfaction with telemedicine services
- Local professionals and service providers report high satisfaction with telemedicine services
- Professionals – local providers report high satisfaction with easy access to tertiary consultation
- UHS is committed to the ongoing use, refinement and dispersion of telemedicine on a statewide basis
- University-based clinicians and community-based clinicians have acknowledged the building of new partnerships through ongoing telemedicine consultations – "the global professional community is smaller."

Summary/Conclusions/Future Efforts

As a result of the successful implementation of this telemedicine project we are taking the following steps:

We are incorporating the telemedicine consultation and evaluation model as part of our regular clinical service venue. We have begun an internal in-service program for our staff to expand these services to all aspects of our clinical service teams of UHS, see Appendix I.
We have hosted a meeting (October 1999) with all 15 directors of Special Educational Services (service system for special education for the entire state of Iowa providing services for all of Iowa's school-age children and youth with disabilities – all types) and have begun the development of a statewide partnering of telemedicine services. Our goal is to collaboratively develop a statewide telemedicine consultation system.

We are in consultation with the Child Health Specialty Clinics (CHSC) the state Title V program for children with special health care needs. This program shares our facility. We anticipate the collaborative development of new telemedicine consultations in concert with this state/federal agency. Plans are currently in process for new telemedicine sites and services: Feeding Disorders in Children with Special Needs, Down Syndrome Clinic, Children with Specialized Nutritional Needs, Postural/Support Service (special mobility, seating consultation), Specialized Consultation for Severe Behavioral Disorder (Des Moines Public School System in central Iowa) and Children with Pain (Juvenile Rheumatoid Arthritis).

We continue to offer consultation services with the four care teams and the present consultations (January 2000) are as follows:

Care Team	In Catchment	Out of Catchment Throughout Iowa	Total Telemedicine Consults
Severe Behavioral Disorders	78	11	89
Feeding/Swallowing	33	3	36
Augmentative/Communication	30	4	34
Special Health/BI	11	8	19
Totals	152	26	178

We are in the process of consulting with state of Iowa insurance/health care providers to encourage payment for clinical services delivered using telemedicine venues.

Lessons Learned

We see the following factors as key lessons learned and issues in enhancing the success of telemedicine in this project for children and families in rural Iowa:

- Collaborative and mutual development of clinical evaluation protocols is essential to success
- Local coordinator of scheduling familiar with local professionals and agencies is necessary
- Specific agenda for the telemedicine consultation prepared in advance insures quality
- Discussion of recommendations for treatments during the telemedicine consultation fosters 'best practices'
- Demonstration of evaluation/treatment procedures by professionals at both sites promotes learning
- Timely scheduling of requested consultations and evaluations is a key to successful local acceptance

- Quality and reliability of technical infrastructure of video connections is needed
- Adequacy and timeliness of written clinical reports following telemedicine consultations insures acceptance
- Prior training of local community-based professionals with telemedicine procedures is imperative
- Confidentiality of studio locations is central and must be maintained
- Pre-determined agenda for telemedicine sessions with designated manager at respective sites promotes a smooth clinical experience for all
- Preliminary introductions of all telemedicine participants – social etiquette is important

Publications

In Appendix K we present several materials; local and national publications, brochures, and video: Telemedicine Case Study. The NLM project was also filmed extensively for a video in 1999 by NLM staff and is being prepared to be distributed nationally. Following is a demonstration of that information:
Abstract – Specialized Interdisciplinary Team Care for Children with Disabilities and Consultations to their Community Service Providers. Dennis C. Harper, PhD in Telemedicine Journal, 5:1, Spring 1999.
Poster Session – Specialized Interdisciplinary Team Care for Children with Disabilities and Consultations to their Community Service Providers. Dennis C. Harper, PhD, et al. At the American Telemedicine Association Final Program, "Telemedicine in the New Millennium: Delivering the Promise." Salt Lake City, UT; April 18-21, 1999.
Poster Session – Pediatric Brain Injury Team Caring for Children throughout Rural Iowa via the Iowa Communications Network. Janet Mapel, James Porter, Claudia Knutson. Presented at the 3rd World Congress on Brain Injury, "Search for Solutions." Quebec City, Canada; June 12-17, 1999.

Comments from Key Participants in the Telemedicine Effort

Mark Moser, University Hospital School, University of Iowa Hospitals and Clinics Administrator, Iowa City, Iowa
"Providers and rural or economically disadvantaged families stand to gain a great deal from telemedicine. When pre-session planning and coordination are appropriately thorough, both community- and tertiary-based professionals experience increased productivity, enhanced rapport and collaboration, and beneficial real-time feedback. The mere occasion to dialogue via a fully interactive medium not only distributes important information quickly and efficiently, but also creates immediate value for clinicians by building partnerships and reducing the need for redundant, unreliable, or resource-intensive communication methods, all of which aggravate hard working professionals. Without question, this "sanity dividend" of telemedicine cannot be overemphasized.

"Similarly, telemedicine provides important advantages over traditional health care encounters for rural, busy, or resource-deficient households. Patients/families can receive expert care directly in their home communities thereby reducing the personal costs, risks, and upheaval (e.g., work/school absenteeism, sibling childcare arrangements, road conditions, vehicle troubles, motel and dining costs, etc.) often associated with travel to specialty referral centers. For families who are especially intimidated by these distant, seemingly impersonal health care settings, telemedicine can encourage them to schedule and keep their appointments by facilitating a more user-friendly experience. In the end, this medium puts consumers at the center of the health care team, giving them the influence and control consistent with the principles of family-centered care and the ever-changing preferences of baby boomers.

"The NLM telemedicine project at University Hospital School has given rise to many strategically relevant issues that have potential to enhance organizational viability in an era of rising consumerism and declining clinical revenues. Although telemedicine does not happen without logistical and technological challenges, and in some cases substantial capital investment, it affords health care yet another avenue through which to conveniently deliver expertise, achieve enhanced marketplace differentiation, and maintain market share. Most importantly, University Hospital School is committed to telemedicine because of its excellent potential to synchronize clinical operations with the evolving expectations of patients, professionals, and payors in a rural state."

<u>Dr. Mary Ellen Becker, Director of Area Education Agency 15, Southern Prairie
Ottumwa, Iowa</u>

"One of the primary benefits to telemedicine services in our area is the convenience of receiving needed health services without having to travel to Iowa City. These benefits to families include less time off work, less travel expense, and the added convenience of not traveling long distances with children. In addition, our Agency can also ensure staff participation in the sessions at a very minimal cost. No longer does participation in an Iowa City evaluation or consultation mean a full day of a staff member's time and expenses. Our professionals can participate in the telemedicine sessions and then resume their duties. No travel time is lost or expense incurred.

"An additional benefit that we have found to be extremely helpful is that teachers, and other local service providers can participate in the sessions which result in much clearer communications for all involved. This communication has resulted in much quicker implementation of ideas and recommendations. Often they can begin the very same day. We have also found that the free flow of information and ideas between participants have generated more recommendations that are functional for the student. If the local service providers have already implemented a suggested recommendation without success, that can be shared and other recommendations pursued. Communication is further enhanced through demonstration of suggested techniques and strategies. Questions can be quickly addressed so that all participants leave the session with a good understanding of the recommendations. This type of communication results in a coordinated and consistent approach employed throughout the child's environment.

"Prior to telemedicine sessions, follow-up consultations involved another trip to Iowa City. Now through telemedicine these follow-up sessions can be scheduled more frequently and quickly when the situation requires. Parents often request that the next follow-up consultation be conducted through a telemedicine session.

"Southern Prairie Area Education Agency has been so impressed with the results of telemedicine services that we are encouraging other Iowa Area Education Agencies to begin using this medium. We are developing a training manual that will be helpful for initiating telemedicine services in other areas. This manual will cover training components for families and professional staff, protection of confidentiality, requirements for the ICN room, and other helpful information for users.

"Southern Prairie Area Education Agency now views telemedicine services as an integral component of our service delivery system. We expect the number of telemedicine sessions to increase each year. This system has proven itself to be efficient, effective, and supportive of our Agency goals.

"On behalf of our Agency, students and families, we would like to express our appreciation for the opportunity to participate in this project."

<u>Cheryll Jones, Specialty Nurse, Child Health Specialty Clinics</u>
<u>Ottumwa, Iowa</u>

"Child Health Specialty Clinics (CHSC) is the state Title V program for children with special health care needs. Child Health Specialty Clinics, Ottumwa Regional Center was one of the cooperating community agencies working with Hospital School on the grant. The Health Services Coordinator of the Ottumwa Regional Center was involved in the referral, evaluation, follow- up and staffing of children seen via the ICN.

"The ICN offers a unique opportunity for staff from CHSC to interact directly with staff from University Hospital School. At the same time, the child, family, and other community providers are also present. This greatly facilitates communication among all those involved with the child and family and helps all providers involved with the child and family to provide more appropriate care and interventions for the children in their own community.

"Evaluation via the ICN offers several benefits to children, families and providers in the delivery of services to children with special health care needs.
The evaluation is done in real time with the family, the community providers and the University Hospital School staff all present at the same time. This allows for real time sharing of information, clarification of questions, and gives immediate feedback to the community in terms of recommendations made by all staff.

"University Hospital School staff have access to the expertise of the community providers regarding what has been tried, what has or has not worked, and what resources are available within the community.

"Evaluations via the ICN have also enhanced the collaboration of the community-based providers. As providers have come together for these evaluations, it has resulted in better communication and closer coordination among the community providers in the follow up of the children.

"As children have been evaluated via the ICN, Hospital School staff have shared information with the community providers regarding the condition being evaluated. This has resulted in increased knowledge and skill on the part of community providers in the evaluation and treatment of these conditions.

"Evaluation and staffing of children via the ICN has made it possible for providers from health, education, and human services agencies to attend these evaluations in their own community. For most providers, it would be impossible to travel to Iowa City to do this.

"This project has demonstrated to us in the community that evaluation of children with special health care needs can be done very successfully via the ICN. Other possible uses of the ICN which might be explored include outreaching specialty clinics from University Hospitals such as genetics, hemophilia, or cardiology. The members of the Regional Feeding Team have also discussed the possibility of utilizing the ICN to provide consultation to schools and providers in our area regarding children followed by our regional team. Child Health Specialty Clinics is also exploring the feasibility of providing some of their Mobile Clinic Services via the ICN. If the staff, commitment and financial resources are available, the possible applications of evaluation and consultation via the ICN are almost limitless."

<u>Jay Heitsman, MD, FAAP, Pediatrician, Ottumwa Pediatrics</u>
<u>Ottumwa Regional Hospital, Ottumwa, Iowa</u>

"I have had many patients evaluated, including patients with disabilities such as brain injury and cerebral palsy. I have utilized this service for the evaluation of children with severe behavioral disorders, feeding problems, and swallowing disorders as well as children with a need for assistive technology. We have had children with heart problems evaluated using echocardiography done remotely from the University of Iowa Hospitals and Clinics campus. From a physician's perspective I cannot be more pleased about what has occurred over these last few years and am also excited about what potential it holds for the future. The patients involved as well as their parents also report a high level of satisfaction with the telemedicine services provided. The physicians, caretakers, school personnel, nurses, social workers, in-home service providers and others involved in the care of patients have found "real time" interaction with the specialists highly valuable. Because of the on-site remote locations they have been able to attend sessions that were impossible to attend previously. This has resulted in increased professional collaboration and rapport and better care of the patient. We have realized a financial savings for families due to travel and time away from work. More timely follow-up has often occurred. Some of these services have allowed us to continue to care for the patient in their local community and local hospital rather than having the patient transported to a tertiary heath center. Of course, there still remain challenges ahead such as improving reimbursement for participation in such patient evaluations and perhaps the development of a more rapidly scheduled consultation service. The limits of these services appear to only depend on how creative we can be. Further research into how to protect patient confidentiality and inappropriate use of these transmissions is also needed as we move towards using the Internet as our connective media."

Parent Comments Receiving Telemedicine Services

Taken from Health Connections (Appendix K), Telemedicine Resource Center, The University of Iowa. Issue: Spring 1999, *Telemedicine "Miracle" Helps Working Mom* – Interview by Ray Bennett; speaking with Rhonda Robinson of Fairfield, Iowa

"Do you think that telemedicine allows for the same quality of evaluation as in a face-to-face evaluation?"

"I think so. I don't really see any difference. Ross has a reflux problem and so they were worried about his eating and how he chewed things. The ICN allowed a nursing specialist to come as a representative for his pediatrician. They were able to do a close-up in on Ross to see how he chewed. The specialists in Iowa City were able to see even how he moved food around in his mouth. That in itself was amazing. There was no question what was going on. It would have been the same if they would have been sitting in the same room with us."
Taken from Health Connections (Appendix K), Telemedicine Resource Center, The University of Iowa. Issue: Spring 1998, *Parents See Savings in Time, Money* – Julie Penrod, Parent, interviewed after a session at the ICN Classroom in Ottumwa.

"What would you say is the biggest benefit of using interactive video?"

"The biggest benefit is probably both the money and time saved traveling back and forth and it makes everybody less tired. I don't think it's as personal as it could be because you're not right there with them, but the more you do it, the more comfortable you probably get. Because it's a new thing, they're probably just as nervous as we are, too, I'm sure. And like all new things it will get better."

Future Challenges for Telemedicine

Telemedicine is much more than video-interactive consultation and needs to be integrated to an informational structure in the health care domain. We have come to this conclusion for a variety of reasons while conducting this research project. The Telemedicine program at University Hospital School should consider interaction with a complex array of services for patients and providers to include internet access to web-based systems for health care information, referral making and access to the health care system, medical record access, and direct contact with tertiary professionals.

The present study did not effectively evaluate in sufficient detail, the specific types of clinical consultations and/or patients that were best suited to Telemedicine use in chronic health care. Follow-up evaluations with chronic health care monitoring were very well suited to the existing telemedicine program both clinically and functionally. Future directions need to clarify more specifically the limits of telemedicine consultation for specific clinical disorders and types of treatment options. This can only be done in a mutual way with local families and local providers.

University Hospital School now must explore interactive information systems for patient health care beyond the Iowa Communication Network. Although this fiber optic network is outstanding in promoting a number of real time contacts to over 700 sites throughout Iowa we need now to explore connections through the Internet directly to patients' homes and into professionals offices. We need to integrate the health care domain throughout rural Iowa. We need to explore technology that allows more direct consultation and review of patients health care needs within their home setting. Such a home-based program is in existence on the University of Iowa campus and is known as Resource Link. We anticipate exploring this system as well as other venues by UHS clinicians.

All individuals involved in the health care professions need to devote considerable time and energy to discussing the importance of Telemedicine contacts with health insurance carriers. The present project did not document specific savings to health care providers since it was not designed to do so. It was, however, very evident that costs were reduced dramatically for local families as well as local providers. Significant savings are likely available to families over time by utilizing Telemedicine services and ultimately to health insurance providers. This benefit has important implications for both public and private health care plans.

Scheduling of Telemedicine consultations with a large number of agencies and individuals is one of our major challenges within the health care system of the University of Iowa. It may be advantageous to explore "Intra-nets" to coordinate specific and confidential information for particular groups of patients and/or professionals. "Point an Click" should permit access to all patients.

Finally, and rather importantly, Telemedicine researchers need to consider designing protocols to evaluate the efficacy of treatments delivered over Telemedicine venues. Randomized and controlled clinical studies are likely to have the best likelihood of giving us specific information about the efficacy of this technology.

Telemedicine needs to become a regular and accessible tool for all health and allied health providers and part of our training in health education in Iowa.

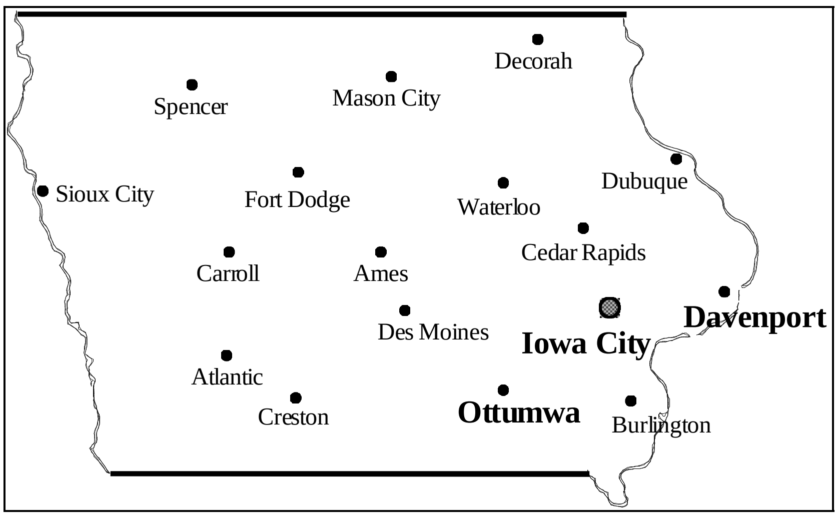
Transmission and Interpretation of Pediatric Echocardiograms from Remote Sites.
Thomas D. Scholz, M.D., Project Director.

Background

Pediatric Cardiology is a medical specialty that primarily cares for infants and children born with congenital heart disease. Eight to nine per thousand neonates are afflicted with congenital heart disease and many present during early infancy as medical emergencies requiring surgical therapy. Other cases are not as emergent but require the special skills of pediatric cardiologists who define the nature of the disorders so that therapy can be recommended to prevent life long debility or premature death.

In order to better serve the state of Iowa, the Division of Pediatric Cardiology at the University of Iowa has maintained an outreach program since 1958 to hold pediatric cardiac clinics throughout the state at regular intervals. Figure 1 presents the sites of these cardiac clinics that are sponsored by the Child Health Specialty Clinics of the University of Iowa.

Figure 1. The Iowa locations of pediatric cardiology outreach clinics maintained by the Division of Pediatric Cardiology at the University of Iowa.



In the past two decades, the technique of two-dimensional echocardiography was developed. This technique allows the accurate diagnosis of most congenital cardiac defects when applied by pediatric cardiologists or technicians under the direction of pediatric cardiologists. In many centers throughout the State of Iowa, echocardiographic instruments have been purchased for adult patients, but in most centers, no pediatric cardiologist is available to direct or interpret studies of children with suspected congenital heart disease.

In March, 1995, the division of pediatric cardiology at the University of Iowa made use of the state-wide fiber optic network (the Iowa Communication Network, or ICN) to establish a DS3 connection between the Pediatric Echocardiography Laboratory at the University of Iowa in Iowa City, Iowa and the Neonatal Intensive Care Unit (NICU) at Methodist Blank Children's Hospital in Des Moines, Iowa. This connection provided sufficient bandwidth to transfer real-time, uncompressed video. Studies showed that there was definitely a positive impact on the timely delivery of therapy to infants in the NICU, particularly for differentiating cyanotic neonates with lung disease from those with congenital heart disease. Infants with lung disease were well cared for locally while those with congenital heart disease were transferred to the University of Iowa for further diagnostic and surgical interventions.

While the DS3 connection provided high quality image data, the availability of fiber connections into hospitals around the state of Iowa was limited. More versatile, easy to establish connections were needed to extend the reach of pediatric cardiology subspecialty services around the state. Further, effective utilization of these services would be important to optimize the use of limited financial and staff resources. Given these considerations, the objectives of this project, as stated in the original proposal were:

- Establish on-line transmission of pediatric echocardiograms from Genesis Medical Center, Davenport, Iowa and Ottumwa Regional Health Care Center, Ottumwa, Iowa to the Pediatric Cardiology Echocardiographic Laboratory in Iowa City.
- Train personnel at the remote site in echocardiographic techniques required to diagnose congenital heart disease in infants and children and indications for obtaining pediatric echocardiograms.
-

This training occurred in two phases:

Didactic Teaching. This included a two-day course on congenital heart disease and the special images that were required in infants and children to visualize these defects.
On-Line Teaching. Receive and interpret echocardiographic data from Genesis Medical Center, Davenport, Iowa and Ottumwa Regional Health Care Center, Ottumwa, Iowa.
Evaluate the impact transmission and interpretation of echocardiographic images has on the care of infants and children in small and medium sized towns in Iowa.

Objectives 1 through 3 were met early in the contract period and were expanded to include other sites that would provide useful data for Objective 4. Objective 4 is ongoing, with the impact of our tele-echocardiography service being continually reviewed. The success in completing each objective and the difficulties encountered are discussed below.

Objective 1

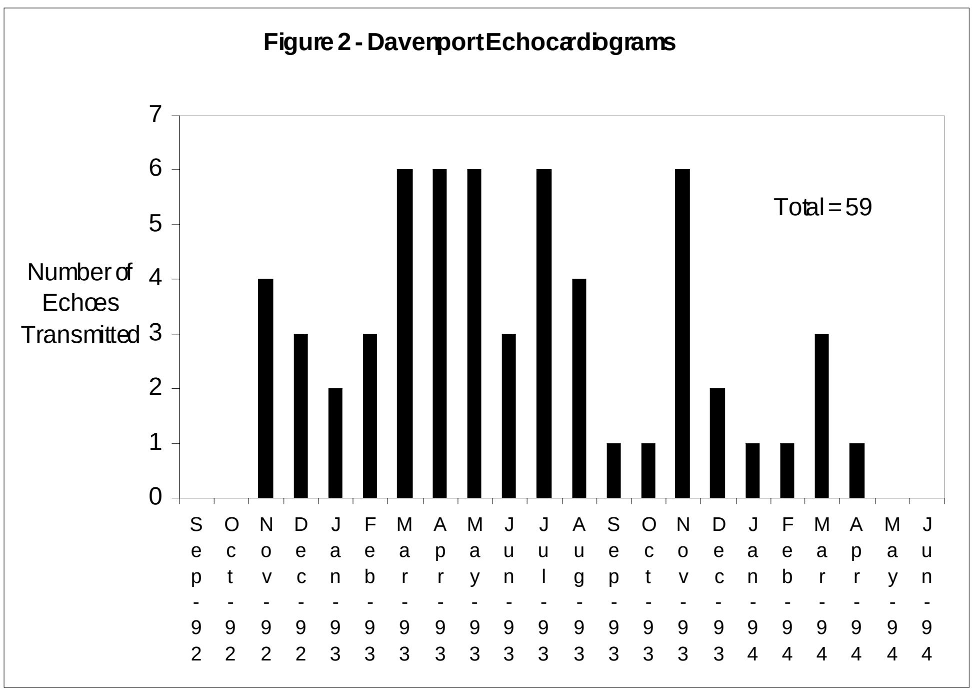
Establish on-line transmission of pediatric echocardiograms from Genesis Medical Center in Davenport in and Ottumwa Regional Health Care Center to the Pediatric Cardiology Echocardiographic Laboratory in Iowa City.

Genesis Medical Center

One of the strengths of this project was the variety of connectivity methods that were implemented and evaluated. Our initial sites in Davenport and Ottumwa were to be connected to the Pediatric Echocardiography Laboratory via ISDN-PRI and DS3 connections, respectively. These two connections were made within the first 9 months of the contract. While these connections were relatively easy to establish technically, there were some unanticipated 'political' challenges. For example, in Davenport, the adult cardiologists with whom we were to collaborate to obtain echocardiograms, developed some concern regarding the potential loss of revenue that would occur if all the pediatric echocardiograms were transferred to the University of Iowa for interpretation.

In addition, the adult cardiologists at Genesis felt comfortable interpreting echocardiograms in older children, which in fact they had been doing for several years, and did not wish to transmit these studies to UI for further interpretation. This group was far less comfortable interpreting studies performed on infants, although they had been reading these studies in the past. As a result, studies that were to be evaluated over the ISDN-PRI connection from Davenport were limited to examinations performed on neonates. Placement of the remote Davenport connection was in the Adult Echocardiography Laboratory at Genesis East Medical Center, near the neonatal intensive care unit.

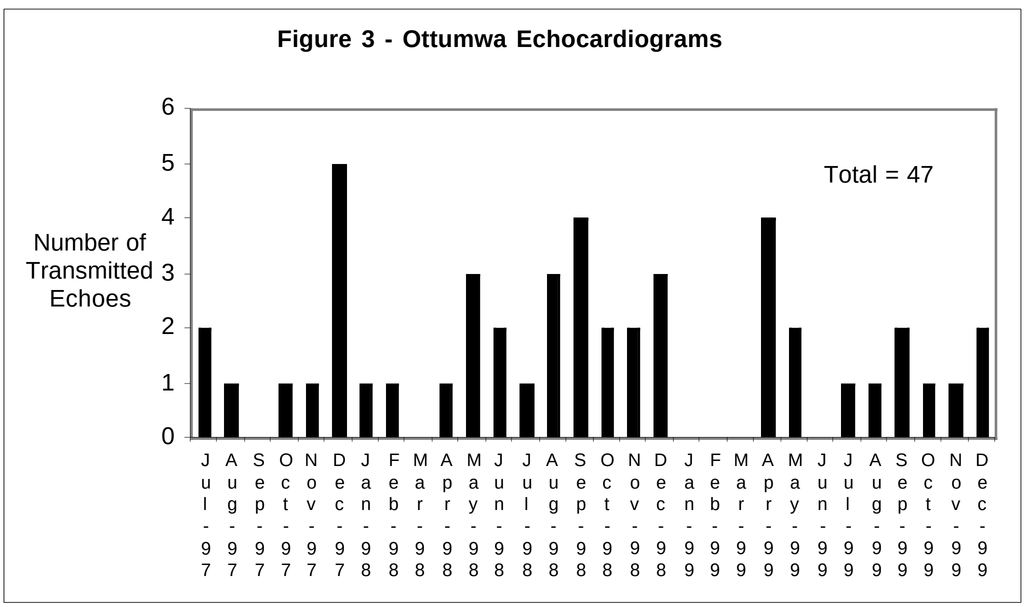
Success of the hardware connection and the agreements with the adult cardiologists did not translate into successful utilization of this connection with Davenport. We anticipated that at least 150 studies per year would be transmitted from Genesis East, but the maximum number of studies that were received in any month was 6. By June, 1998, 20 months after establishing the ISDN-PRI link to the Adult Echocardiography Laboratory at Genesis East Medical Center, the number of studies being transmitted dropped to zero despite the hardware connection functioning well (Figure 2).



The explanation for the limited number of transmissions from Davenport appeared to be three-fold. First, there was limited understanding by pediatricians and family practitioners within the community of how an examination was to be ordered. This was addressed by Dr. Scholz presenting to the Davenport medical community the indications for and methods of ordering an echocardiogram as well as generating a brochure that was circulated to practitioners in the Quad Cities community (Attachment 1). Second, the primary neonatologist at Genesis Medical Center had a poor relationship with neonatologists at the University of Iowa and, by extension, had limited interest in interacting with the pediatric cardiologists at the University of Iowa. This difficulty was addressed by explaining the potential benefits that his patients would receive and that transmitting the study would often prevent transferring a patient. Third, a pediatric cardiologist had set up practice in Moline (one of the Quad Cities on the Illinois side of the Mississippi River). Her availability limited the number of echocardiograms performed by the Davenport-based cardiologists.

Ottumwa

The political landscape in Ottumwa was not quite as complicated as it was in Davenport, but this site also presented some challenges. Concern arose over the anticipated revenue stream between two departments in the Medical Center: the radiology division of the Ottumwa Regional Hospital (who performed sonograms on the body, other than the heart) and the Ottumwa Clinics who had the only echocardiographer and echocardiographic machine. Although infants requiring echocardiograms would be in the nursery in the hospital and the DS3 connection was also in the hospital, the Clinics were actually providing the service. After a lot of negotiating, the hospital was convinced that the amount of money they would be losing was small compared with the benefit the patients would receive. The pediatricians in Ottumwa were strong advocates for the tele-echocardiographic service, and continue to be. Although the number of studies performed in Ottumwa is small (Figure 3), it is consistent.



Sioux City

The Division of Pediatric Cardiology at the University of Iowa has had an interesting relationship with practitioners in the town of Sioux City, which lies on the western-most border of the state. For nearly two decades, pediatric cardiologists from the University of Iowa have been providing subspecialty services to this community. Utilization has increased to the point where 20-40 patients per month were seen at the clinic held in Sioux City's St. Luke's Hospital. Early in the NLM contract, pediatric echocardiograms were being overnight-expressed to the University of Iowa Pediatric Cardiology Division for interpretation. To better serve this community and provide additional data for analysis, an ISDN PRI-based connection to St. Luke's Hospital was established in December, 1997. This connection was heavily utilized until the arrival of a pediatric cardiologist in this community in September, 1998. As shown in Figure 4, utilization dropped to zero shortly after his arrival.

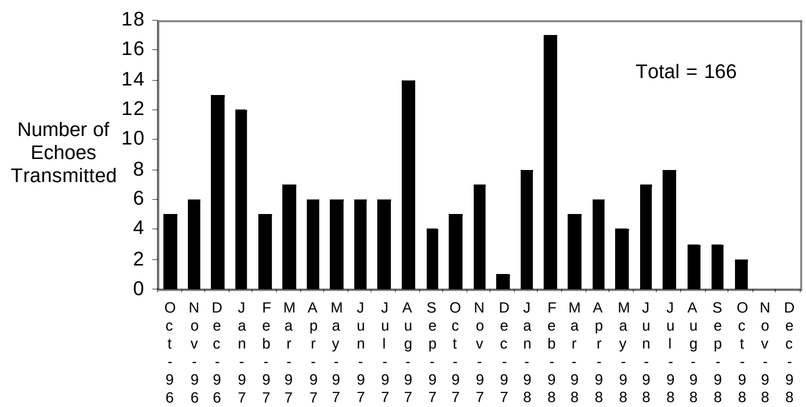
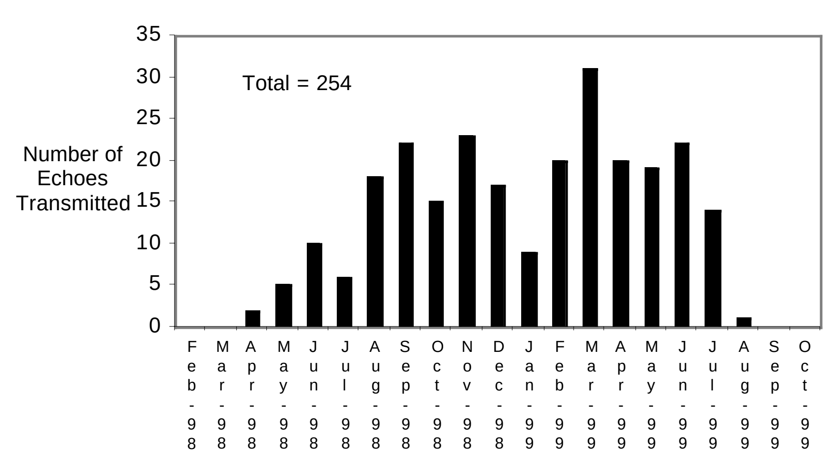


Figure 4 - Sioux City Echocardiograms

Cedar Rapids

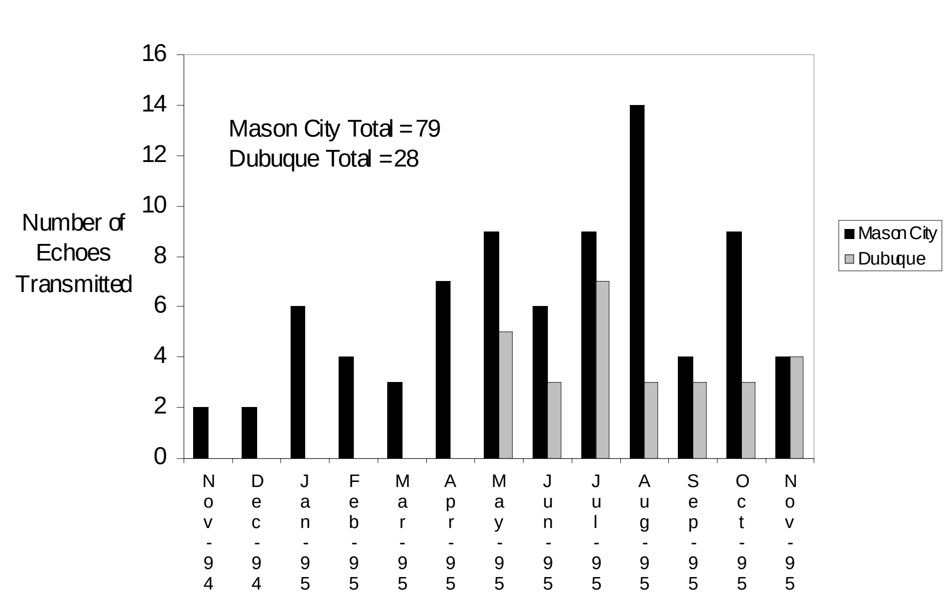
In December, 1998, we started receiving echocardiograms from Cedar Rapids, the third largest city in Iowa. A pediatric cardiologist had been in this community and had left in October, 1998. Primarily initiated by the adult cardiologists in that community, a tele-echocardiography service interaction with the University of Iowa Pediatric Echocardiography Laboratory was established. Initial discussions about using a T1 or ISDN-PRI connections to transmit over the 25 miles distance did not seem economically sound and a courier service transfer method was arranged. This seemed sensible since recorded pediatric echocardiograms often run 20-30 minutes, which would be comparable to the time to drive the distance. This service was heavily utilized (Figure 5) until a pediatric cardiologist was again hired into that community in August, 1999, at which time the number of studies being sent to the University of Iowa Pediatric Echocardiography Laboratory dropped to zero (Figure 5). This "low-tech" telemedicine connection was effective and provided interesting data that will be discussed below.

Figure 5 - Cedar Rapids Echocardiograms



Other hospitals and practitioners throughout the state of Iowa heard about the tele-echocardiographic connections and were interested in implementing this service in their community. In September, 1998, discussions began with hospitals in Mason City and Dubuque. In December, 1998 the Pediatric Echocardiography Laboratory began to receive studies by overnight courier from Mason City and they were connected in August, 1999 via an ISDN-PRI link. Dubuque was also connected by an ISDN-PRI connection in June, 1999. Both these sites have been active, providing excellent data for analysis (Figure 6).

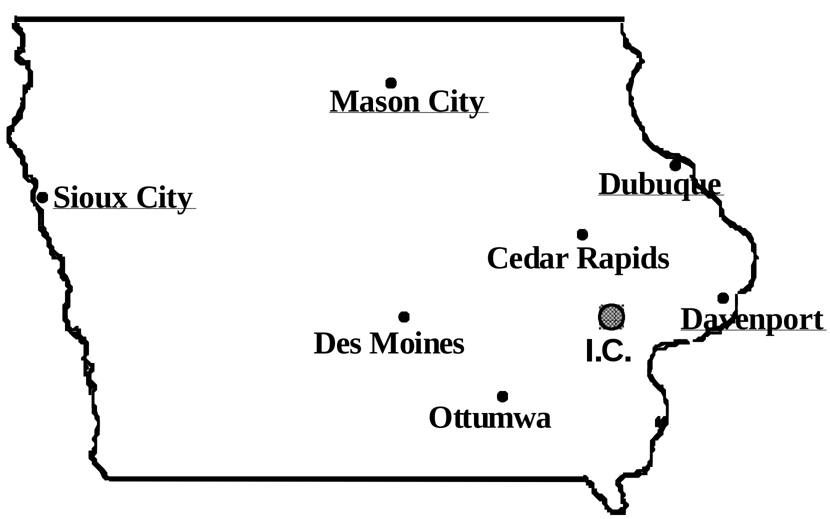
Figure 6 - Mason City and Dubuque Echoes



In order to economize on these connections, our telecommunications engineers were able to configure the existing ISDN-PRI hardware in the Pediatric Echocardiography Laboratory to dial into existing telecommunications hardware already in place at the hospitals in Mason City and Dubuque, resulting in considerable cost savings.

In summary, we exceeded the objectives set forth for hardware connections. The Des Moines site has been maintained and sites in Davenport and Ottumwa were initiated. In addition, a courier arrangement was established with Cedar Rapids and initially with Mason City. As discussed below, the courier arrangement with Cedar Rapids (25 mile distance) worked well, suggesting that this "low-tech" type of connection may be effective for urban centers where transfer distances are short. ISDN-PRI connections with Mason City and Dubuque have also been established that were not originally planned. All of these sites have provided valuable data for the assessment of the impact telemedicine has on the delivery of pediatric cardiology subspecialty services. A summary of the sites is shown in Figure 7 that have been connected to the University of Iowa Pediatric Echocardiography Laboratory during the course of the contract and have generated data for analysis.

Figure 7 -The Iowa locations of remote tele-echocardiography sites that were active during the contract. Currently active sites include the DS3 sites of Des Moines and Ottumwa and the ISDN-PRI connections to Mason City and Dubuque. Sites that were served that are longer transmitting echocardiograms include Cedar Rapids (courier), Davenport (ISDN-PRI), and Sioux City (ISDN-PRI).



Objective 2

Train personnel at the remote sites in echocardiographic techniques required to diagnose congenital heart disease in infants and children and indications for obtaining pediatric echocardiograms.

Even the highest fidelity connection will not result in improved patient management if the data on which decisions are based is of poor quality. Objective 2 was implemented throughout the contract period to be certain that the highest quality echocardiograms were being transmitted for evaluation. A two-day course was designed in conjunction with Ms. Diana Knoedel and the sonographers in the Pediatric Echocardiography Laboratory to train other echocardiographers from outside institutions (Attachment 2). This course was approved for 11.5 Category 1 credit hours (see Attachment 3). Sonographers from all the outside institutions that were using our tele-echocardiography service attended the course (Attachment 4). The comments of the attendees were generally quite favorable, with most the sonographers finding the training extremely helpful. Usually, we tried to identify one, or at most two, sonographers at each institution to participate in the training process. We found that limiting the number of sonographers performing pediatric echocardiograms at each institution was crucial to optimize image quality. The differences between performing pediatric and adult echocardiograms was found to be great enough that unless a sonographer concentrated on most the studies being performed at a given institution, they would soon forget some of the exam details and the quality of the study would decline.

The continued, on-line, instruction was important for honing the skills of the echocardiographers at the outside institutions. Typically, while a study was being transmitted, it would be reviewed by one of the sonographers in the Pediatric Echocardiography Laboratory and feedback would be given to the remote technician. This on-line instruction was found to be considerably more time efficient than having our sonographers assist during image acquisition. Also, by reviewing the echocardiograms while they were sent, additional views could be obtained if the remote sonographer was uncertain if sufficient detail existed. The patients would often remain in the remote echocardiography laboratory until the transmission was completed. This type of feedback, which may take place in the initial moments of sending a study, is one reason that the courier connections were less optimal than transmitted studies (see below).

A clear conclusion of this contract was that if a tele-echocardiography connection is to be established, initial training of the remote technicians, along with continued on-line refreshers, is essential to the success of the project and the care of the patient.

Objective 3

Receive and interpret echocardiographic data from Genesis Medical Center, Davenport, Iowa and Ottumwa Regional Health Care Center, Ottumwa, Iowa.

Our connections during the contract period were used extensively. As discussed above, not only were the centers in this objective included, but also sites in Des Moines, Sioux City, Mason City, and Dubuque. The currently active sites include Ottumwa, Des Moines, Mason City, and Dubuque. Over the period of the contract, 633 echocardiograms were received and interpreted in the Pediatric Echocardiography Laboratory. The distribution of the studies among the various sites is shown in Figures 2 – 6.

Objective 4

Evaluate the impact transmission and interpretation of echocardiographic images has on the care of infants and children in small- and medium-sized towns in Iowa.

This portion of the contract was crucial in order for us (and others) to effectively determine how and when to implement tele-echocardiography services. We took several approaches to assess the impact and utilization of tele-echocardiography. Findings related to this objective have been incorporated into two manuscripts, one that has been published and one that has been submitted. The following paragraphs summarize data that are included in the enclosed manuscripts (Attachment 5).

An initial analysis of the data collected looked at the percentage of normal and abnormal echocardiograms that were transmitted. Data from these analyses were presented at the National Meeting of the American Telemedicine Association in April, 1999, and published in the *American Journal of Cardiology* (Scholz, TD and Kienzle, MG. "Optimizing Utilization of Pediatric Echocardiography and Implications for Telemedicine." *Am J Cardiol* 83:1645-1648, 1999). A reprint of this article is included in Attachment 6. The main findings of this study were that, compared with pediatric cardiologists attending outreach clinics in the same communities, local physicians ordered a significantly higher percentage of normal echocardiograms. For all ages, community physicians ordered echocardiograms that turned out to be normal 42% of the time compared with the 24% normal rate of pediatric cardiologists. The difference between the two groups became more marked when children over one-year of age were considered. In this group, 83% of the echocardiograms that were ordered locally were normal, compared with 25% ordered by the pediatric cardiologists attending outreach clinics in the same communities. While such a significant difference would have been thought to result in considerably greater expense, this was difficult to prove and depended greatly on the expense of the running the clinic. For our study group, many of the echocardiograms came from Sioux City in the western part of Iowa. Because of the distance, this was an expensive outreach clinic to run because of the cost of transporting physicians to Sioux City in small, private planes. The actual costs associated with performing the high percentage of normal studies were comparable to running the outreach clinic. Of course, these costs excluded the additional clinic-related expenses such as the time parents needed to take off work and the anxiety of having to wait for an outreach clinic. Assuming our rates normal echocardiograms are comparable to others, the data included in the manuscript will assist other programs in calculating the costs of implementing such a service.

Given the variety of connections we had made with institutions around the state of Iowa, we were in a unique position to evaluate the various implementations. Three types of connections were evaluated:

- a shared DS3 line
- an ISDN-PRI interface
- a low-tech courier interaction – one from a hospital 25-miles away (Cedar Rapids) and one from a hospital 170-miles away (Mason City).

Our initial assessment of the various types of links included prospectively monitoring several time intervals between when an echocardiogram was performed and when the final report was faxed to the referring physician. The following times were recorded for each echocardiogram interpreted by the Pediatric Echocardiography Laboratory:

- Time when the echocardiogram was recorded
- Time when the echocardiogram was received at the Pediatric Echocardiography Laboratory
- Time when the echocardiogram was interpreted by a pediatric cardiologist
- Time the results of the echocardiogram were phoned to the referring physician
- Time the final report was faxed to the referring physician and echocardiographic laboratory

Various time intervals were calculated and compared between the DS3 connection, the ISDN-PRI link, the 25-mile courier delivery, and the 170-mile away courier site. Overall comparisons were made using analysis of variance with pairwise comparisons made by Tukey's F-test. For all analyses, $p < 0.05$ was considered significant. Figure 8 shows the time interval between when the echocardiograms were recorded and when they were received at the Pediatric Echocardiography Laboratory. This time interval was significantly increased for studies sent from the 170-mile away courier site (Mason City). The other three groups were not significantly different. This reflected the fact that studies done in Mason City were typically done in the afternoon and sent by overnight courier to the Pediatric Echocardiography Laboratory. Often, courier transfer of studies was considered a low priority if the sonographer felt the examination was normal. Clearly, this placed a lot of importance on the interpretative skills of the sonographer, which were not always reliable.

Figure 8 - Time from when echocardiogram was recorded locally until it was received.

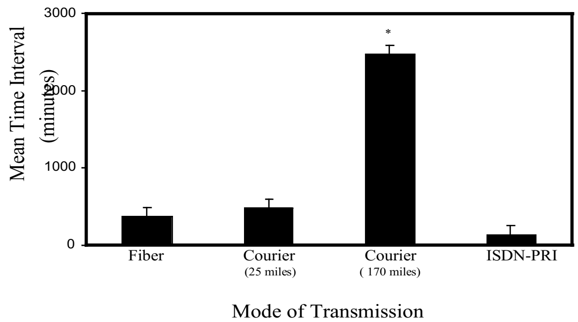
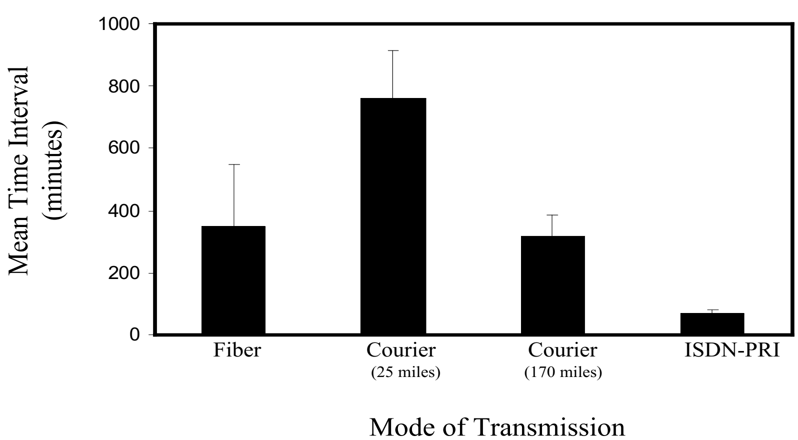


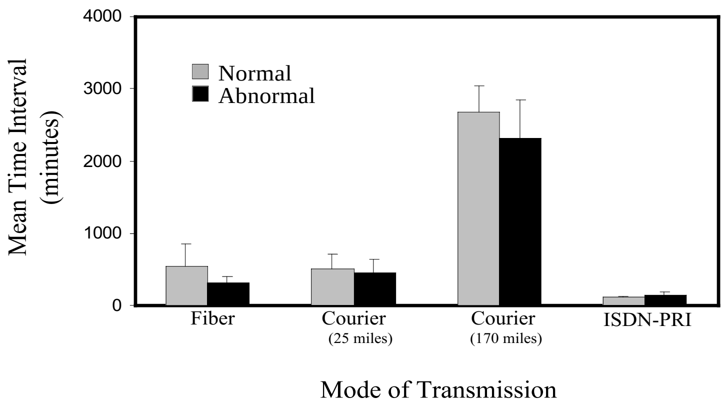
Figure 9 shows that all studies, regardless of the mode of transmission, were interpreted equally promptly in the Pediatric Echocardiographic Laboratory. The critical time interval between when an echocardiogram was performed and when the results were phoned to the referring physician was calculated from the intervals presented in Figures 8 & 9. Due to the longer transmission time for courier deliveries form the Mason City site (170-miles away), this time interval remained significantly increased for these echocardiograms (2699 ± 339 minutes) compared with those transmitted by DS3 (720 ± 230 minutes) and ISDN-PRI (191 ± 24 minutes) connections and by courier from 25 miles away (1233 ± 258 minutes).

Figure 9 - Time from when echocardiogram was received until the verbal report was given to the referring physician.



We were interested to see if echocardiograms, possibly recognized as abnormal by the sonographer, reduced the transmission time for any of the modes of transfer. Though we did not have data relating to the remote sonographers' interpretations, studies were stratified based on the interpretation by the pediatric cardiologists. Figure 10 shows that, comparing studies read as normal or abnormal, there was no significant difference between when an echocardiogram was performed and when it arrived in the Pediatric Echocardiographic Laboratory. This suggested that studies read as abnormal were not treated with an increased level of urgency.

Figure 10 - Time from when echocardiogram was recorded locally until it was received for normal and abnormal studies.



We next put together a quality assurance (QA) assessment that was distributed to all the pediatricians and family practitioners who were using the tele-echocardiographic service during the 1998 calendar year. The complete UI Quality Assessment survey is included in Attachment 7. (Please note: Quality Assurance Assessments are required by patient care services at UIHC and were therefore performed outside the scope and responsibility of this contract.) Responses were scored from 1 to 5 in most cases except Yes/No/Do Not Know responses which were quantitated from 1 to 3. Questions were grouped into those assessing:

1. Turnaround time, image quality and diagnostic accuracy
2. Helpfulness of results
3. Satisfaction with the service
4. Any perceived parental concerns (from the telemedicine consult format to insurance issues)

Results were numerically averaged to compare those receiving service via the DS3 connection and by courier and to compare responses from pediatricians and family practitioners.

A total of 35 physicians from three remote sites send 255 echocardiograms to the Pediatric Echocardiography Laboratory for interpretation during the study period. 21 questionnaires were returned (60%) which included physicians who had referred 159 infants and children for remote echocardiograms (62% of total echocardiograms performed). Statistical analyses were performed on these responses. During the study period, no echocardiograms were transmitted using the ISDN-PRI connection. Thus comparisons were made between physicians 25-miles away using a courier service (in Cedar Rapids) or the DS3 transmission (Des Moines and Ottumwa) method as well as between pediatricians and family practitioners using the service.

Interesting responses between those using the DS3 connection (n = 8) and those using courier service (n = 13) are summarized in Table 1. Of note were those physicians using a courier service to transmit echocardiograms who were found to be significantly more concerned about the availability of a pediatric cardiologist and the image quality than those using the DS3 transmission method. This finding reflected the fact that the patients at the courier delivery site had usually left the local echocardiographic laboratory before a pediatric cardiologist ever reviewed the echocardiogram. This placed greater responsibility on the sonographer to obtain a complete study or required patients to be recalled if examinations were incomplete or nondiagnostic.

Physicians using the DS3 connection felt more strongly that the availability of tele-echocardiography significantly improved their ability to care for neonates. Timely clinical decisions are critical in neonates. Differentiating pulmonary versus cardiac disease in ill newborn infants is possible with an echocardiogram allowing appropriate treatment to be promptly instituted, lessening morbidity and mortality.

Notable similarities between the two groups were concerns for, and satisfaction about, turnaround times (Table 1). Each group was equally enthusiastic about recommending the tele-echocardiography service to their colleagues.

Table 1: Referring physician views of the tele-echocardiographic service – comparison by mode of transmission

Survey Question	DS III (n=8)		Courier (n=13)		P value (By Wilcoxon Rank Test)
	Mean	**S.E.M.**	**Mean**	**S.E.M.**	
Concerns about availability of the Pediatric Cardiologist[1]	2.12	0.45	3.30	0.26	.02
Concerns about quality of image[1]	2.0	0.42	3.30	0.31	0.0272
Extent to which the availability of Telemedicine based services improved their ability to care for neonates[2]	4.12	0.61	3.61	0.23	0.0211
Extent to which telemedicine services more or less helpful than onsite consultation in clinical decision making and clinical management of neonate[3]	3.12	0.48	2.8	0.32	0.0175
Concerns about the turnaround time[1]	2.75	0.62	3.46	0.27	0.39

Satisfaction with the turnaround time[4]	3.25	0.36	3.61	0.21	0.3549
Recommend the use of Telemedicine services to colleagues for neonates[5]	1.25	0.25	1	0	0.2393
Recommend the use of Telemedicine services to colleagues for infants[5]	1.40	0.35	1	0	0.1366

Scale:
1 – 1 = Not concerned at all; 2 = Very little concerned; 3 = A little concerned; 4 = Quite concerned; 5 = Mostly concerned
2 – 1 = Not improved at all; 2 = A little better; 3 = Somewhat better; 4 = Much better; 5 =Improved to a great extent
3 – 1 = Much less helpful; 2 = Less helpful; 3 = About the same; 4 = More helpful; 5 = Much more helpful
4 – 1 = Not satisfied at all; 2 = Somewhat satisfied; 3 = Satisfied; 4 = Very satisfied; 5 = Completely satisfied
5 - 1 = Yes; 2 = No; 3 = Do not know

Although the number of family practitioners utilizing the tele-echocardiography service was small (n = 5), their responses were compared to the responses of the pediatricians using the service (n = 16). Interestingly, compared to family practitioners, pediatricians felt the tele-echocardiography service was significantly more helpful in caring for children over the age of five years (Table 2). The prevalence of innocent heart murmurs in this age group has been noted to be as high as 55%. Many of the children in this age range, undergoing school physicals examinations, will have murmurs heard and will be referred to pediatricians for further evaluation. Following inconclusive examination by the pediatrician, many of these children have been sent for echocardiograms rather than waiting for an outreach clinic or having the patient travel to the tertiary care center.

<u>TABLE 2:</u> REFERRING PHYSICIAN VIEWS OF THE TELE-ECHOCARDIOGRAPHIC SERVICE – COMPARISON OF RESPONSES FROM PEDIATRICIANS AND FAMILY PRACTITIONERS

Survey Question	**PEDIATRICIANS (n=16)**		**FAMILY PRACTITIONERS (n=5)**		**P value (By Wilcoxon Rank Test)**
	Mean	**S.E.M.**	**Mean**	**S.E.M.**	
Extent to which the availability of Telemedicine based services improved their ability to care for children above the age of five[1]	4.10	0.30	2.40	0.51	.0241
Extent to which Telemedicine services more or less helpful than onsite consultation in clinical decision making and clinical management of infants[2]	2.60	0.26	3.60	0.40	.0717
Recommend the use of Telemedicine services to colleagues for neonates[3]	1.12	0.12	1	0	0.654
Recommend the use of Telemedicine services to colleagues for infants[3]	1.14	0.15	1	0	0.6198

<u>Scale:</u>

1 – 1 = Not improved at all; 2 = A little better; 3 = Somewhat better; 4 = Much better; 5 =Improved to a great extent
2 – 1 = Much less helpful; 2 = Less helpful; 3 = About the same; 4 = More helpful; 5 = Much more helpful
3 – 1 = Not satisfied at all; 2 = Somewhat satisfied; 3 = Satisfied; 4 = Very satisfied; 5 = Completely satisfied

Family practitioners tended to think the tele-echocardiography service was more helpful than onsite consultations for infants, though this result did not reach statistical significance (Table 2). Notable similarities between the pediatricians and family practitioners was their enthusiasm for recommending the tele-echocardiography service to colleagues and their comfort level in discussing the echocardiogram results with parents.

OVERALL CONCLUSIONS

The objectives as initially stated were met and exceeded. The tele-echocardiography service instituted by the Pediatric Echocardiography Laboratory at the University of Iowa effectively distributed tertiary-level pediatric cardiology care to rural areas of the state where these services were not readily available. Having an echocardiogram to review greatly facilitated the interaction between referring physicians and the pediatric cardiologists, allowing for more precise discussions regarding the appropriate management of the child with suspected congenital heart disease. Appropriate training of the sonographers at the remote sites was crucial for obtaining diagnostically useful images. Of the various modalities used to transfer echocardiograms to the Pediatric Echocardiography Laboratory, a dedicated ISDN-PRI interface has certainly been the most convenient. However, the time interval between when an echocardiogram was performed until it arrived in the echocardiography laboratory did not differ between ISDN-PRI connections, a shared DS3 line, or 25-mile courier delivery. The slowest time intervals for transferring studies and contacting referring physicians with results were for studies sent by courier over a 170-mile distance since many of these studies were sent by overnight delivery.

The cost-effectiveness of providing tele-echocardiographic services is difficult to precisely quantitate, though initial analyses (even with a high percentage of remotely ordered normal echocardiograms) suggested the service was competitive. Delays in evaluation were avoided (such as the adolescent waiting to be cleared for a sports physical) and physician satisfaction with the service was very high. Clearly, infants and children with suspected congenital heart disease were better served if accurate diagnostic information could be obtained locally and interpreted in a timely fashion. Tele-echocardiography accomplished this result with a combined program of sonographer training, telecommunication engineer ingenuity, and pediatric cardiologist expertise.

The Impact of Telemedicine on the Delivery of Psychiatric Services to Rural Areas. Barbara M. Rohland, M.D. (Texas Tech University Health Sciences Center); Michael Flaum, M.D. (University of Iowa).

Introduction

The potential for telecommunications to increase access to psychiatric care for persons who live in rural communities is being evaluated through the careful study of new and existing applications of mental health in telemedicine. In theory, a substantial portion of face to face psychiatric consultations could be delivered via real time interactive audio-visual transmission. However, financial, technical, administrative, political, and clinical issues often impede successful program implementation and sustainability. For successful telemedicine service delivery to occur, an infrastructure to support the transmission of telecommunications must be established. This includes an assessment of the technical capacity of local networks, equipment costs, and the cost of installation and maintenance of lines and equipment. Even when technical and financial issues concerning the mechanism and logistics of transmission have been resolved, the delivery of services by physicians may require interstate physician licensing and securing agreements of service reimbursement from third party payers. To be recruited as telemedicine service providers, physicians must be comfortable using telemedicine technology and feel that they are able to provide an adequate standard of care via this mechanism. Finally, even when the mechanism, the means, and the provider have been identified, telemedicine services must be acceptable to patients, family members, and to their referring physicians if the service is to be utilized.

Because of these and other barriers, applications of telemedicine in rural areas and its integration into existing systems of rural care delivery have been limited despite its intuitive appeal and despite significant increases in capacity due to technological advances. The present report describes the experience and outcome of a three year project funded by the National Library of Medicine to develop, implement, and evaluate a Telepsychiatry program in a rural Midwestern state.

Description of Work Performed

Prior to initiation of this study, the investigator (Dr. Rohland) had been providing services to each of the two proposed study sites though the University of Iowa Clinical Outreach Program. In the first year of the study, careful planning was directed at developing procedures such as triage, on-site assistance, and outcome measurement at each of the proposed telemedicine study sites.

In years two and three, Telepsychiatry services were delivered to one new rural site per study year. In each of years two and three, the other rural site served as a no-telemedicine treatment control group and patients at those sites received traditional face-to-face services through the pre-existing clinical outreach program. After one year as a Telepsychiatry demonstration site, the experimental site was converted to no-telemedicine treatment control, and the no-telemedicine treatment control was converted to a Telepsychiatry demonstration site in a crossover design.

YEAR 01(OCTOBER 1996-SEPTEMBER 1997): PROJECT PLANNING AND DEVELOPMENT OF STUDY PROTOCOL

Study Protocol

- Informed consent to participate as a study subject:
- Patient must be 18 years of age or older
- Patient must be able to give informed consent to participate in the study
- Patient must have a local primary care provider and provide consent to communicate with them

Patient Groups Evaluated:
- Patients who have, or are referred for evaluation of, DSM-IV Axis I diagnoses of schizophrenia, schizoaffective disorder, bipolar affective disorder, major depressive disorder, panic disorder, other anxiety disorder, obsessive-compulsive disorder.
- Patients with mental retardation or other organic brain disease with co-occurring psychiatric manifestations if they meet other criteria and the facility or family member agrees to provide transportation to the telemedicine site.
- Nursing home residents and persons in other residential and group home care are included if they meet other criteria and the facility or family member agrees to provide transportation to the telemedicine site.

Patient Group Exclusions:

- Persons under 18 years of age
- Persons with severe dementia (MMSE less than 20)
- Persons with a history of violence or repeated history of suicide attempt (more than once over the preceding 12 month period)
- Persons with a primary axis II diagnoses of borderline personality disorder or antisocial personality disorder
- Persons with a primary diagnosis of alcohol or other substance abuse and who do not have a co-occurring psychiatric condition (e.g., depression or anxiety disorder)
- Patients referred for court ordered assessment

Services Offered:
- diagnostic evaluation
- medication management

Services Not Offered:
- Psychotherapy
- Substance abuse treatment

- Supportive services
- Emergency psychiatric consultation (e.g., assessment of persons acutely suicidal)
- Assessment of persons acutely intoxicated
- Medical (non-psychiatric) services
- Provision of Emergency Services:

Emergency psychiatric consultation was not provided through the study. The local provider (referring MD or agency) was specified as the point of first contact for the patient in case of an emergency. Persons requiring emergency psychiatric evaluation (including patients who are acutely suicidal) were to be referred to local providers, local emergency rooms, or referred to the services at the UIHC department of psychiatry. Patients were given information on how to access these services at the time of their enrollment to the study.

<u>Staffing Requirements for Provision of Clinical Services</u>

A. Physician

Provides direct psychiatric services (evaluates patient, prescribes medication and other treatment, provides documentation of services provided)

B. Nurse

On clinic site: Obtains patient records prior to visit; obtains informed consent from the patient (participation in study and permission to communicate with local provider); obtains intake information; obtains self-report instruments to track clinical outcome; administers AIMS/MMSE when appropriate to evaluate reliability of on site vs. telemedicine assessment; assists patients in utilizing telemedicine technology (telemedicine site only); administers consumer satisfaction survey at completion of each visit; serves as liaison to local care takers (e.g., CSP program, VNA, family practice doctor).

Off clinic site (telemedicine and face to face site): First point of contact for patient and patient related calls between visits; primary liaison with local site coordinator and other local providers; obtains records on new patients prior to visit; update on patient status on return patients; recruits and enrolls patients in study protocol (pre-screen patients prior to scheduling for appropriateness to telemedicine protocol, obtains informed consent for participation and consent to communicate with local provider); coordinates outcomes data management from both sites with telemedicine research assistant.

C. Clerical/ Administrative Support

Schedules appointments; Maintains patient chart and documents patient visits; documents resource utilization (billing/encounter data)

<u>Program Evaluation</u>

A. Demographic/epidemiological data

Patient ID
Gender

Age at enrollment to the study
Diagnosis (ISD9/DSM-IV)
Marital Status
Educational Background

B. Symptom measurement
Initially, we planned to measure symptom changes with the BPRS (a generic, clinician rated instrument for symptom assessment in persons with serious affective and psychotic disorders) and the SCL-90 (a generic patient self-report instrument) at every patient visit. However, neither generic nor disease specific measures of symptom severity were obtained when we realized that the sample size would be too small and diversity of patient diagnoses too large for interpretation of these results to be meaningful (see description of protocol modification, year 2, below). The MMSE was obtained on patients who were referred for evaluation of dementia and who demonstrated confusion and memory problems consistent with dementia. Patients were not offered enrollment in the study if they had an MMSE score less than 20 because they were not felt to be able to give informed consent for participation and because their impairment precluded effective participation.

C. Assessment of functional status
Initially, we intended to obtain a generic, patient report of functional status (SF-36) on all persons and a clinician rated measure of functional status specific for persons with serious and persistent mental illness (MCAS). However, when we realized that the sample size would be too small and diversity of patient diagnoses too large for interpretation of these results to be meaningful, an alternative instrument was selected (see description of protocol modification, year 2, below). The instrument used was the Global Assessment of Functioning (GAF), a clinician administered, generic measure. This measure was obtained at all patient visits and was scored by consensus of the treating physician and the on-site nurse immediately following each visit.

D. Treatment process indicators (Resource Utilization)
Process of Care Log I (Resource utilization reported by patient to the nurse prior to the physician visit) and Process of Care Log II (Resource utilization prescribed by provider completed by the nurse following each visit) was recorded for each patient contact.

E. Patient satisfaction (self-report)
Two measures of satisfaction were obtained, the Satisfaction with Ambulatory Services 4.0 (Adult) on all patients and the Telemedicine Patient Satisfaction Survey (on telemedicine patients only). NLM contract funds were not used for any of the surveys or studies. At the end of the year 2, these instruments were obtained on all patients at their first and second visits only, since analysis of the data from year 1 showed that little useful information about satisfaction was gained at visits subsequent to visit 2 (see protocol modification, year 3, below).

F. Utilization/Cost

Several resources were required in order to implement and carry out this project including hours of psychiatrist time, hours of nursing time, line charges, travel time and travel cost. Additional costs of equipment and equipment maintenance were also incurred. However, since the equipment at the central and each remote site were used for several projects and purposes, it would be difficult to estimate the equipment costs specific to the Telepsychiatry project. Administrative costs must also be considered as part of the total costs of Telepsychiatry. However, costs of scheduling and medical documentation were relatively independent of the mode of service delivery in this project and therefore administrative costs specific to Telepsychiatry were not calculated.

YEAR 02: OCTOBER 1997- SEPTEMBER 1998. PROGRAM IMPLEMENTATION, SITE I

A. Telemedicine Site - Van Buren County, Iowa
Control (Face-to-Face) site - Washington County, Iowa

Modifications to the study protocol, Year 2

Change in outcome evaluation: assessment of clinical status (Reported in Year 2, Quarterly reports 1 and 2). Initially, we planned to measure symptom changes with the BPRS (a generic, clinician rated instrument for symptom assessment in persons with serious affective and psychotic disorders) and the SCL-90 (a generic patient self-report instrument) at every patient visit. Similarly, we intended to obtain a generic, patient report of functional status (SF-36) on all persons and a clinician rated measure of functional status specific for persons with serious and persistent mental illness (MCAS). However, requirements of the initial evaluation protocol were time consuming and felt to be too disruptive to the process of clinical care (i.e., required too much of the nurses' time, and the space constraints at the Washington County site in Year 2 made administration of these instruments difficult). Furthermore, since the number of enrolled subjects per each diagnostic group was small, the ability of these instruments to measure statistically significant differences in clinical outcome was felt to be limited. Hence, the following measures were eliminated from the study outcome assessment: BPRS and SCL-90 (symptom assessment), SF-36 and MCAS (functional status). Clinical outcome was assessed by the GAF (Global Assessment of Functioning), a clinician rated scale of global functioning. Resource utilization logs were completed before and after each patient contact by the on-site nurse.

YEAR 03: OCTOBER 1998- SEPTEMBER 1999. PROGRAM IMPLEMENTATION, SITE II

Telemedicine Site Washington County, Iowa
Control (Face-to-Face) Site Van Buren County, Iowa

Modifications to the study protocol, Year 3

Addition to study protocol (Reported in Year 3, Quarterly report 1). Despite local and central efforts, only a small number of subjects accepted enrollment into the telemedicine study. The small number of study enrollees posed severe limitations for data analysis and interpretation of the study results. We hypothesized that the limited study enrollment was due to the lack of acceptability of telemedicine by persons seeking psychiatric services in rural areas. Hence, we designed an ancillary study entitled "Telemedicine Services in Rural Iowa: Mental Health Care" in order to test this hypothesis. The study objective was to measure the interest, demand, and willingness of rural Iowans to use telemedicine mental health services in order to assess the potential impact of telepsychiatry on mental health service delivery in this rural state. The specific aim of the study was to provide a population based needs assessment of telmedicine mental health services via a telephone survey to a simple random sample of rural Iowa county residents. The study and its findings are reported in a manuscript scheduled for publication in early 2000 (Rohland BM, Saleh SS, Rohrer JE, Romitti P: Telepsychiatry: Acceptability to a Rural Population. In Press, Psychiatric Services (MS.#R-5538). In brief, the study yielded the following findings: While two-thirds of respondents were willing to participate in Telepsychiatry, some survey respondents expressed reluctance due to concerns of confidentiality and the perception that this type of service would be impersonal. Medicare enrollees and older respondents were less willing to endorse the use this mechanism of health care delivery than were younger survey participants.

Change in outcome evaluation: assessment of patient satisfaction (Reported in Year 3, Quarterly report 2). Patient satisfaction at each visit in year 2, and at the first and second visits in year 3 was obtained. Data collection protocol was modified after year 2 so that patients completed a satisfaction assessment at only their first and second visit at both sites. Analysis of the data collected during year 2 of the study suggested that satisfaction data beyond the second visit was not useful. Collection of satisfaction data beyond the second use of either service modality was reported to be burdensome and redundant by the patients and created unnecessary work for nursing and research staff.

Change in key project staff (Reported in Year 3, Quarterly report 2). In project year 3, the project director (BMR) announced that she had accepted a position at Texas Tech University in Lubbock, Texas and would resign her position at the University of Iowa effective June 1, 1999. Arrangements were made to reassign project direction from Dr. Rohland to Michael Flaum, M.D., a faculty member in the Department of Psychiatry, effective June 1, 1999. As of June 1, 1999, Dr. Flaum agreed to provide telemedicine consultation and oversee the project until its date of scheduled completion, September 30, 1999. A subcontract from the University of Iowa to Texas Tech was approved by the program director (Dr. Kienzle) and the NLM project staff (COA 23). Dr. Rohland agreed to be responsible for the final data analysis and preparation of the final project report.

STUDY RESULTS

Year 1: The work performed in the year 1 study period (October 1996-September 1997), was summarized in the Telepsychiatry: Phase I Report.

Year 2: The work during study year 2 (October 1997-September 1998), was described in a manuscript (Unpublished) entitled: "If We Build It, Will They Come? Assessment of Quality in Rural Telepsychiatry". (Attachments 1 and 2) The information contained in this manuscript is summarized, below, and presented in Tables 1-3.

During the second 12-month period of the study, psychiatric care was provided to patients at the two rural sites. At site 1, services were provided through telemedicine; at site 2, patients received services through traditional face-to-face contact. Quality of care was measured by self-report of patient satisfaction in several domains in addition to physician assessment of functional status. In the first year of the study, 47 patient contacts in 12 patients occurred at the telemedicine clinic compared to 29 patient contacts in 13 patients at the face-to-face site. Telemedicine recipients were older, more likely to be male, and less likely to have a high school or greater education. Diagnostic categories were similar in both groups. A net change of +9.4 in GAF was observed over the 203-day mean duration of enrollment in telemedicine patients, compared to +4.3 over a 169-day mean enrollment in the face-to-face clinic. Overall satisfaction with care was similar in both groups (4.1 versus 4.3) but eye contact was rated lower in the telemedicine group compared to the face-to-face group (3.7 versus 4.6). From the results in the first year of the study, we concluded that telemedicine provides an acceptable and adequate alternative to face-to-face delivery of psychiatric services to patients who live in rural areas as evidenced by observations of similar ratings of patient satisfaction and clinical status in both groups.

Table 1: Summary of Patient Characteristics (Study Year 2)

	Telemedicine site	**Face-to-face site**
Number of patients	12	13
Number visits	47	29
Number of patients with more than one visit	9	7
Mean number and range of visits/patient in patients with more than 1 visit	4.9 2-8	3.3 2-5
Gender		
Male	7/12	3/13
Age (years):		
Mean	67.8	39.5
Range	43.4-86.6	29.3-54.4
Ethnicity		
Caucasian	12/12	13/13
Diagnosis		
Depression	5	6
Bipolar affective illness	2	2
Schizophrenia	2	1
Dementia	1	0
Anxiety disorder	1	4
Alcohol dependence	**1**	0
Marital status		
Married	5/11	6/13

Education		
High school diploma	6/10	11/13

Table 2: Clinical Status (GAF) In Patients with 2 Or More Visits (Year 2)

	Telemedicine N=9	**Face-to-face N=7**
GAF first visit		
Mean	61.7	57.1
Range	35 – 85	50 – 70
GAF last visit		
Mean	71.1	61.4
Range	40 – 85	55 – 70
Change in GAF between first and last visit		
Mean	+9.4	+4.3
Range	-15 to +20	-5 to +15

Table 3: Mean Satisfaction, Rated On A Scale From 1 (Poor) To 5 (Excellent) In Patients Having Two Or More Visits (Study Year 2)

	Telemedicine N=9		**Face-to-face N=7**	
	Visit 1	Visit 2	Visit 1	Visit 2
Convenience of clinic	4.0	4.1	3.5	3.8
Ease of seeing provider of choice	4.3	4.1	4.2	4.8
Technical skills	4.1	4.5	4.3	4.7
Attention (listening)	4.6	4.8	4.5	4.7
Time spent with clinic staff	4.3	4.6	4.3	4.3
Outcome of medical care	3.6	4.3	4.2	4.5
Helpfulness of instruction and education	3.8	4.3	4.2	4.3
Eye contact with physician during visit	4.0	4.3	4.7	4.8

Year 3: (October 1998-September 1999). See Tables 4-6.

During the final 12-month period of the study, psychiatric care continued to be provided to patients at two rural sites. At site 1, services that had been provided via telemedicine in year 2 were switched back to face-to-face; at site 2, patients who had been receiving traditional face-to-face services began a 12-month period of telemedicine. Quality of care continued to be measured by self-report of patient satisfaction in addition to physician assessment of functional status. In year 3 of the study, 18 patient contacts in 5 patients occurred at the telemedicine clinic. Four out of five of these patients had also received face-to-face services in year 2 of the study. At the face to face site, 28 patient contacts occurred in 8 patients. All 8 patients had been enrolled as telemedicine patients at that site in year 2. In year 3, the marital status and education level of telemedicine recipients was similar to those of the patients seen in the face to face clinic (see Table 4). A net change of 5.0 in GAF was observed over the 201.4-day mean duration of enrollment in telemedicine patients, compared to 5.7 over a 256.5-day mean enrollment in the face-to-face clinic. Satisfaction with care was generally higher in the telemedicine group although eye contact was rated the same in both groups of patients (4.4). Similar to the results in the first year of the study, we concluded from the data in the final year of the study that telemedicine provides an acceptable and adequate alternative to face-to-face delivery of psychiatric services to patients who live in rural areas as evidenced by observations of similar ratings of patient satisfaction and clinical status in both groups.

Table 4: Summary of Patient Characteristics (Study Year 3)

	Telemedicine site (WC)	**Face-to-face site (VBC)**
Number of patients	5	8
Number visits	18	28
Mean number of visits/patient	3.6	3.5
range	2-5	1-8
Gender		
Male	3/5	6/8
Age (years):		
Mean	45.9	62.1
Range	(34-58)	(43-81)
Ethnicity		
Caucasian	5/5	8/8
Diagnosis		
Depression	**1**	4
Bipolar affective illness		2
Schizophrenia	1	1
Dementia		
Panic disorder	2	
Alcohol dependence		1
Other	1	
Marital status: Married	3/5	3/8
Education: HS diploma	4/5	5/8

Table 5: Clinical Status (GAF) in Patients with Two or More Visits (Study Year 3)

	Telemedicine N=5	**Face-to-face N=7**
GAF first visit		
Mean	72.0	66.4
Range	60-80	35-90
GAF last visit		
Mean	67.0	60.7
Range	40 – 80	35-90
Change in GAF between first and last visit		
Mean	-5.0	-5.7

Range	-30 to +10	-20 to +3

Table 6: Mean Satisfaction, Rated On A Scale From 1 (Poor) To 5 (Excellent) In Patients Having Two Or More Visits (Study Year 3)

	Telemedicine N=5		**Face-to-face N=5**	
	Visit 1	Visit 2	Visit 1	Visit 2 (n=4)
Convenience of clinic	3.8	4.2	4.4	4.25
Ease of seeing provider of choice	4.0	4.8	4.2	4.25
Technical skills	4.6	4.8	4.2	4.25
Attention (listening)	4.6	4.8	4.4	4.25
Time spent with clinic staff	4.4	4.6	4.2	4.25
Outcome of medical care	4.2	4.2	4.0	4.0
Helpfulness of instruction and education	4.2	4.4	4.2	4.25
Eye contact with physician during visit	4.4	4.4	4.4	4.0

Study Limitations

The most significant limitation of the study was the small number of study subjects. The small number of study sites (2) and small number of patients at each site posed the risk that the study findings were attributable to unique site and patient factors that could not be controlled. Hence, the generalizability of the study results to broader population groups and other applications is uncertain. The telemedicine consultations were primarily delivered by a single psychiatrist (BMR) and unique physician characteristics and practice style could have had more effect on the outcome than the mechanism of service delivery. Although the crossover design partially compensated for these limitations, nevertheless, a small-scale study of this type should be regarded as a pilot demonstration and not a full-scale evaluation.

Lessons Learned

Technical. No significant, pervasive, or consistent technical problems were experienced during the course of the study. Having the assurance of consistent, reliable, and immediate access to technical expertise and support (provided through the Telemedicine Resource Center) was essential to the success of this project. Such support will be important in order to recruit and retain both physicians and patients to the use of this technology.

Financial. Financial barriers present the greatest obstacle to the widespread implementation of Telepsychiatry in rural areas. It is doubtful that local sites would have supported the costs of equipment and transmission had it not been provided through grant support. Furthermore, third party reimbursement would not have covered nurse or physician services that were provided under the auspices of this project. Because our telemedicine nurse traveled to both the face to face and the telemedicine sites, costs of transportation were incurred at both sites. For an ongoing program, contracting with a local provider for on-site clinical coordination and support would have eliminated the cost of transportation to the telemedicine site.

Political. Most rural delivery systems are fragile. Telemedicine should be considered as an ancillary rather than a primary service; it should seek to supplement or support local resources rather than to replace, substitute or compete with them. If the introduction of Telepsychiatry by an outside provider erodes the financial base of local providers, local resources will be difficult to maintain and the community will become dependent on a distant service provider who may not be committed to the overall well being of the local community. Local providers (and patients) may be reluctant to embrace Telepsychiatry (or other telemedicine services) if they are uncertain of the commitment and endurance of the providing agency. Furthermore, telemedicine is unlikely to be supported by local care providers (including referring entities) if they perceive it as being competitive to existing local resources, particularly services that they themselves provide. In the preliminary planning stages, local providers at potential telemedicine sites expressed willingness to refer only patients that represented a financial loss to the local provider (no third party coverage, or to groups of patients that were covered under a capitated contract that was deemed inadequate by local providers such as prison consultation and forensic court ordered evaluations).

Clinical. An on site clinician (e.g., a nurse) is essential to the quality of Telepsychiatry. Although it raises concerns regarding confidentiality, it is essential for a clinical staff person to be present with the patient during the telecommunication. They must be able to trouble shoot technical problems (such as turning up the sound or refocusing the camera) as well as being prepared to address psychiatric emergencies such as threats of suicide or violence. At one of our sites, a patient expressed the intent to blow up a local electric company vehicle during the course of the evaluation. Appropriate (and immediate) follow-up would have been difficult had an on-site nurse not been present during this communication. The cost of an on-site provider, in addition to the telemedicine provider, is not likely to be reimbursed. Hence, telemedicine should not be promoted as cost saving. If done with an acceptable standard of clinical quality, it is likely to be more expensive than traditional services. The primary advantage of telemedicine is that it provides a means to increase access to necessary or desirable services by patients who would otherwise not receive services or be underserved. Telepsychiatry should be viewed as an ancillary as opposed to a primary mechanism of service delivery in the provision of psychiatric services to persons who live in rural areas.

Administrative. Administrative costs of scheduling and record documentation appear to be comparable to face to face assessment. However, it is important for measures to assure confidentially in the transfer and receipt of medical information via video transmission to be in place.

Acceptability. Telemedicine is an acceptable alternative to traditional face to face services by physicians, patients, and family members when it offers an advantage of convenience and/or cost over available alternatives. When patients have an established relationship with a treating psychiatrist, they appear to be willing to receive continuing services via telemedicine and appear to be able to do so without adverse consequences.

Comments/conclusions: The nature of the interaction between physician and patient is an important determinant of care quality. Psychiatry is often cited as an appropriate application of telemedicine because its technical requirements for physical examination are assumed to be less than those required for examination by other specialties. Furthermore, it is often assumed that the transmission of sound and facial expression require less sophisticated technical resolution than does the observation of more detailed physical characteristics of a patient. However, even when the audio and visual transmission of telemedicine allows adequate communication between patient and physician, the provision of medical services via telecommunication alters the subjective experience of the communication between physician and the patient. How does the interface of telemedicine affect the empathy felt by the physician toward the patient? How does the real or perceived empathy of the physician that is transmitted via telemedicine affect the subjective experience of empathy felt by the patient? Does the patient feel that they are being listened to? Do they sense that they are being seen? Do they feel that they are being cared for? In psychiatry, it has been stated that the relationship between physician and patient is more than a component of treatment, it is the essence of the treatment itself. While it is difficult to make a case that communication via telemedicine can be equal or superior to face-to-face communication, some applications of Telepsychiatry do appear to be feasible. When face-to-face services are not available, it appears to be a viable alternative to provide basic psychiatric assessment and care. While it is not optimal to substitute Telepsychiatry for an initial face-to-face assessment, it is reasonable to provide follow-up care via telemedicine, once the initial face-to-face contact has been made and rapport has been established. Because of its high start up and maintenance costs, Telepsychiatry should not be promoted as cost saving in comparison to traditional face to face services or in comparison to no services at all. However, telemedicine provides an important adjunct to traditional services and is an acceptable alternative to the delivery of timely services that may not otherwise be accessible to people who live in geographically remote or inaccessible areas.

ENHANCED COMMUNICATION FOR ACUTE EVALUATION AND TREATMENT OF VASCULAR ISCHEMIA Investigative Team: James Torner, Ph.D., Harold Adams, M.D., Michael Winniford, M.D, Patricia H. Davis, M.D, Ricardo Guerra, M.D., Bradley Doebbeling, M.D., MS Thomas Taylor, Ph.D., Karla Grimsman, R.N, Jeff VandeBerg, MS, Tim Shie, Mike Mueller, Adlai Griffith, James McKnight

Specific Objectives

The aims of the project were to 1) develop the database and software for rapid diagnosis and consultation of acute myocardial infarction (AMI) and acute brain infarction (ABI) patients; 2) integrate the software with other data sources and teleconferencing software; 3) train physicians in the use of the software and teleconferencing; 4) implement the system in 9 hospitals of varying sizes representing different capabilities and patient populations; 5) evaluate use of the system between hospitals; 6) evaluate physician satisfaction at the local rural hospital and the tertiary hospital; and 7) evaluate patient outcomes in terms of time to treatment, need for transfer, survival, functional outcome and cost of care.

Accomplishments by Objective

The development of criteria for diagnosis and defining data elements for a consultation database

To develop the database and software for rapid diagnosis and consultation of AMI and ABI patients, we used clinical guidelines from the American College of Cardiology and the American Heart Association for AMI[1] and from the American Heart Association for ABI[2]. Demographic, diagnostic and treatment information to determine the eligibility of a patient for thrombolytic therapy and to aid in the consultation is included. The database contains a checklist to determine type of stroke and eligibility for thrombolytic therapy.

In order to disseminate the criteria for acute stroke and thrombolytic therapy we placed descriptions on the Virtual Hospital website located at the following addresses:
http://www.vh.org/Providers/ClinGuide/Stroke/Index.html
http://www.vh.org/Providers/ClinGuide/Stroke/Scaleind.html
http://www.vh.org/Providers/ClinGuide/Stroke/TPAProt.html
http://www.vh.org/Providers/ClinGuide/Stroke/TranProt.html
http://www.vh.org/Providers/ClinGuide/Stroke/SAHProt.html
http://www.americanheart.org/Scientific/statements/1996/0902.html

A conference entitled "Emergent Management of Acute Stroke: Advances in Treatment and Technology" was held October 10, 1997. Participants included physicians and other personnel from the telemedicine networked hospitals as well as other interested health practitioners. The program included presentations on "Emergent Recognition and Diagnosis of Stroke", "Imaging of the Brain in Persons with Suspected Stroke", "Management of Intracranial Hemorrhage", "Indications for and the Use of rtPA in Management of Acute Ischemic Stroke", "Ancillary Care of Persons give rtPA", "Use of Antithrombotic Drugs in Management of Ischemic Stroke", "Use of the National Institutes of Health Stroke Scale", "Development of Local emergency Stroke Services", and "Use of Telemedicine in Management of Stroke". This conference not only acquainted health care providers with current guidelines but also introduced the use of telemedicine for acute consultation for stroke.

2) The development of a database and software for rapid diagnosis and consultation of AMI and ABI patients

Patient data are maintained using a 4D relational database software on Macintosh computers. Patient data are entered into a standalone database at the rural hospital using a computer located in their local emergency room. The database is used to collect specific information regarding stroke symptoms, patient medical history, examination results, and results of laboratory tests. When a consultation with medical personnel at The University of Iowa Hospitals and Clinics

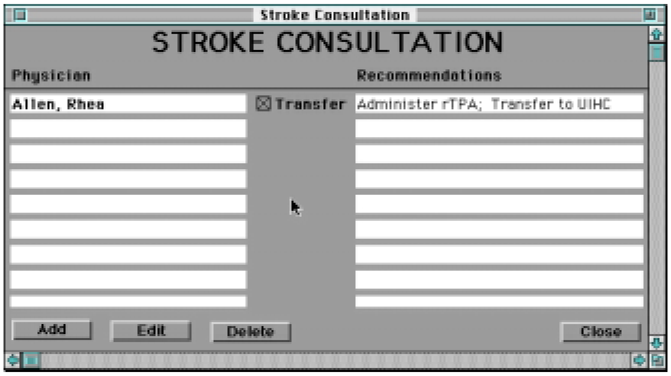
(UIHC) is requested, the patient's data are transferred electronically to a computer located in the UIHC emergency room. UIHC personnel then have access to all of the patient data collected at the rural hospital. A hard copy of the data can also be generated at either site for printing, faxing or general reference.

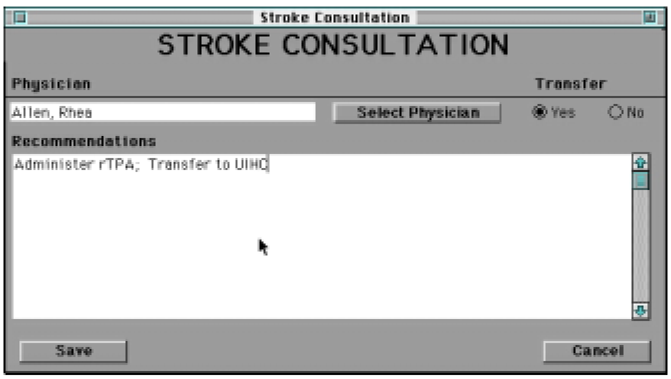
The database consists of four distinct sections: trauma, cardiac, stroke and general emergency. Each section guides the user through an interview process to ensure that sufficient data is collected to make accurate diagnosis and recommendations. Physicians from within the aforementioned specialties at UIHC oversaw the design of the interview process, the database forms and the data accuracy checks incorporated into the database. Every effort was made to ensure the accuracy and validity of the data that is entered. Data values that fall within well-defined ranges are checked for acceptability, and the user is warned if they fall into either an unusual but acceptable range or into a completely unacceptable range.

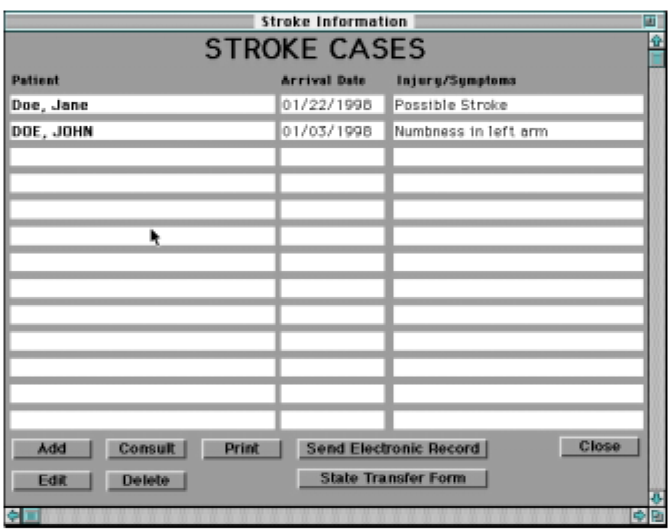
The databases are secured by way of a user id and password security system. Access to patient records is strictly controlled by the rural hospitals. Only they can initiate a transfer of data to the UIHC emergency room computer. The satellite hospitals can also send patient records directly to UIHC staff member's home computers if an immediate evaluation is required. Once a patient record has been reviewed at UIHC, it is deleted from that system. Patient records remain on the rural hospital's computers until their staff deems it appropriate to delete the records locally.

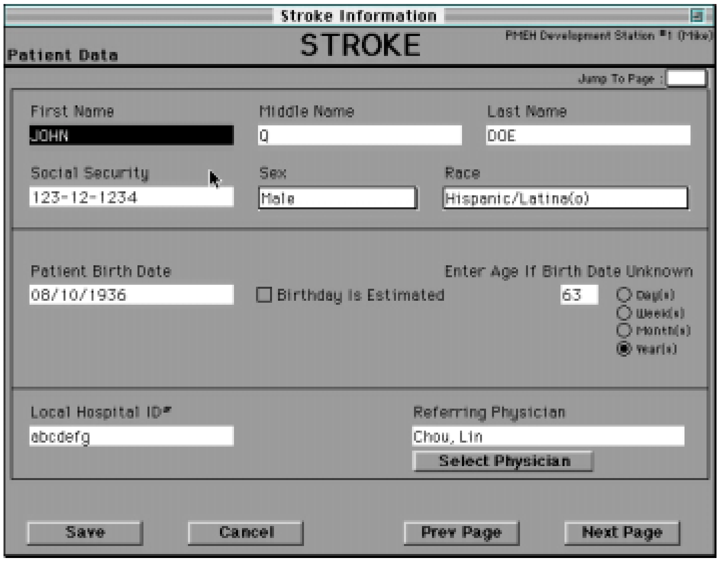
In progress is the design of a single database on a World Wide Web server. This will allow central administration of the database and will greatly reduce the cost of maintaining a dedicated line to each of the rural hospitals. Security and confidentiality will be maintained using Windows NT challenge/response logon validation, digital certificates, and secure socket layer Internet protocols.

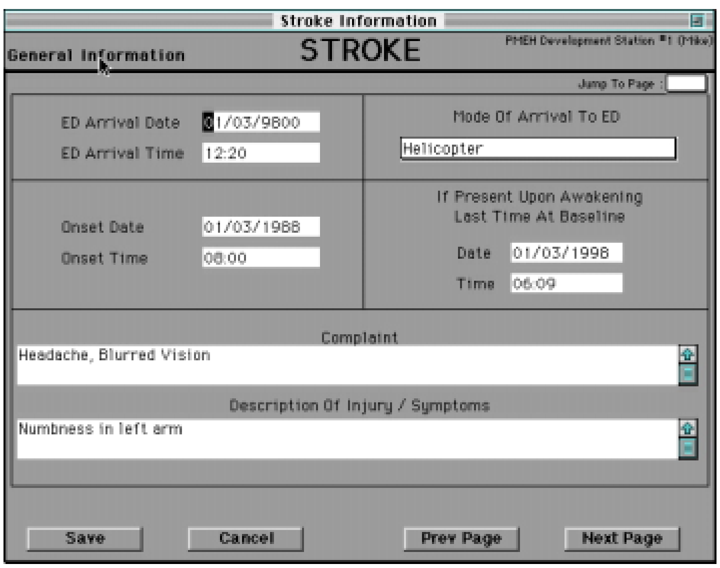
The current database screens are on the following pages. Similar screens exist for heart attack consultation except those screens include decision information.

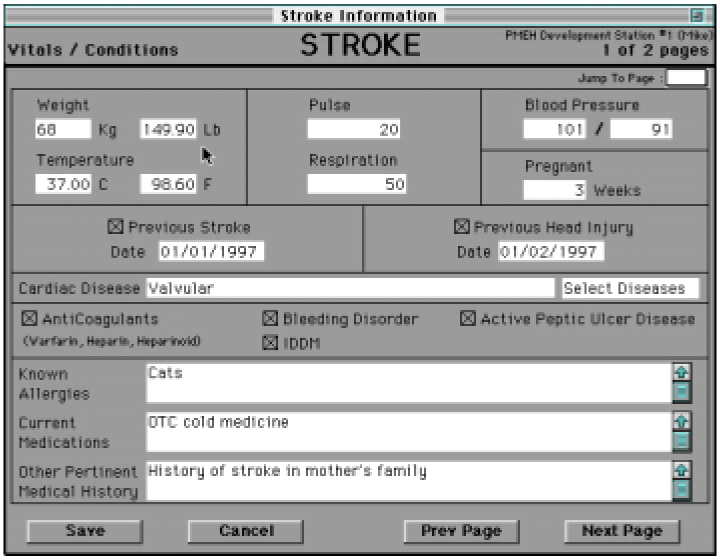

Stroke Consultation
STROKE CONSULTATION
Physician
Recommendations
Allen, Rhea
Transfer
Administer rTPA; Transfer to UIHC
Add
Edit
Delete
Close

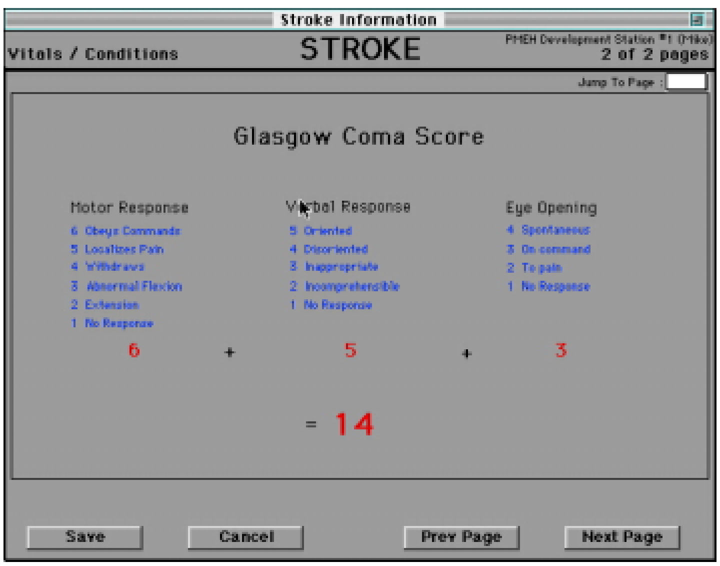

Stroke Consultation
STROKE CONSULTATION
Physician
Transfer
Allen, Rhea
Select Physician
Yes
No
Recommendations
Administer rTPA; Transfer to UIHC
Save
Cancel

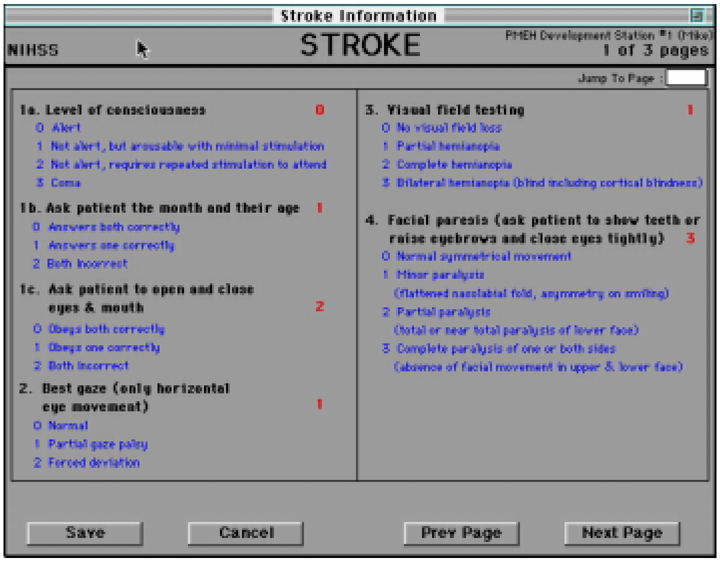

Stroke Information
STROKE CASES
Patient
Arrival Date
Injury/Symptoms
Doe, Jane
01/22/1998
Possible Stroke
DOE, JOHN
01/03/1998
Numbness in left arm
Add
Consult
Print
Send Electronic Record
Close
Edit
Delete
State Transfer Form

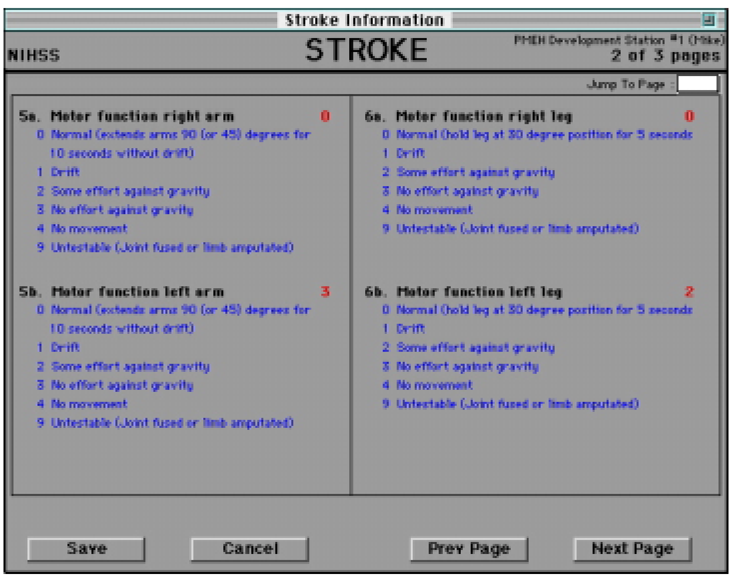

Stroke Information
STROKE
Patient Data
Jump To Page :
First Name
JOHN
Middle Name
Q
Last Name
DOE
Social Security
123-12-1234
Sex
Male
Race
Hispanic/Latina(o)
Patient Birth Date
08/10/1936
Birthday is Estimated
Enter Age If Birth Date Unknown
63
Local Hospital ID#
abcdefg
Referring Physician
Chou, Lin
Select Physician
Save
Cancel
Prev Page
Next Page

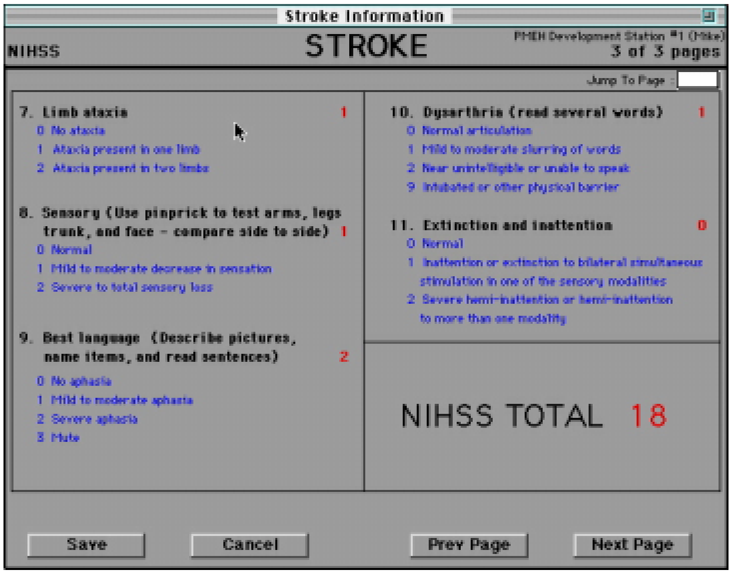

Stroke Information
STROKE
General Information
Jump To Page :
ED Arrival Date
01/03/9800
ED Arrival Time
12:20
Mode Of Arrival To ED
Helicopter
Onset Date
01/03/1988
Onset Time
08:00
If Present Upon Awakening
Last Time At Baseline
Date
01/03/1998
Time
06:09
Complaint
Headache, Blurred Vision
Description Of Injury / Symptoms
Numbness in left arm
Save
Cancel
Prev Page
Next Page

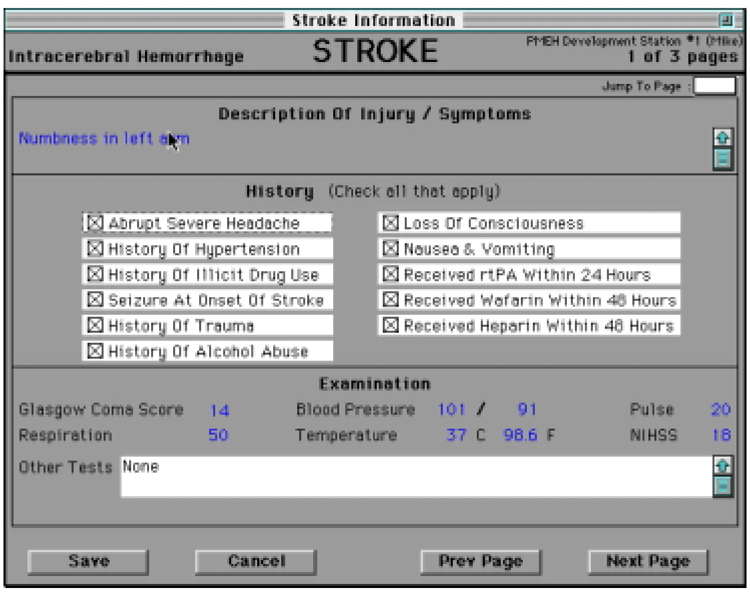

Stroke Information
Vitals / Conditions
STROKE
PMEH Development Station #1 (Mike)
1 of 2 pages
Jump To Page :
Weight
68 Kg 149.90 Lb
Temperature
37.00 C 98.60 F
Pulse
20
Respiration
50
Blood Pressure
101 / 91
Pregnant
3 Weeks
Previous Stroke
Date 01/01/1997
Previous Head Injury
Date 01/02/1997
Cardiac Disease Valvular
Select Diseases
AntiCoagulants
(Warfarin, Heparin, Heparinoid)
Bleeding Disorder
IDDM
Active Peptic Ulcer Disease
Known Allergies
Cats
Current Medications
OTC cold medicine
Other Pertinent Medical History
History of stroke in mother's family
Save
Cancel
Prev Page
Next Page

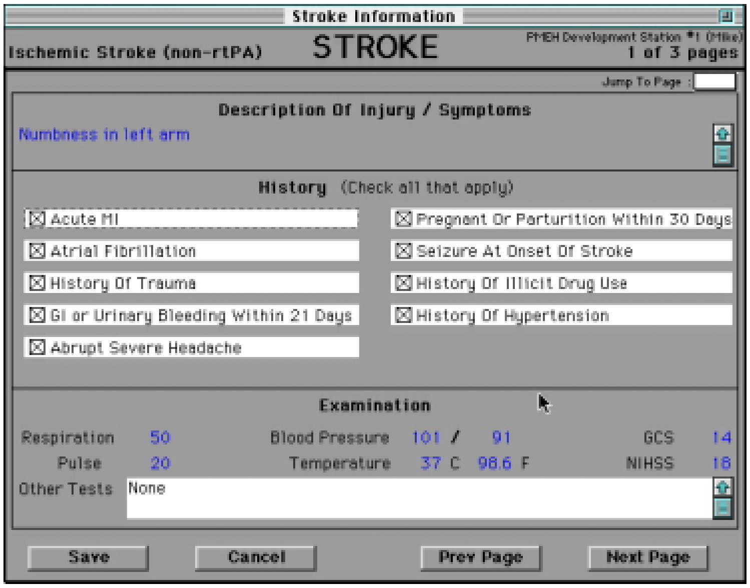

Stroke Information
Vitals / Conditions
STROKE
PMEH Development Station #1 (Mike)
2 of 2 pages
Jump To Page :
Glasgow Coma Score
Motor Response
6 Obeys Commands
5 Localizes Pain
4 Withdraws
3 Abnormal Flexion
2 Extension
1 No Response
Verbal Response
5 Oriented
4 Disoriented
3 Inappropriate
2 Incomprehensible
1 No Response
Eye Opening
4 Spontaneous
3 On command
2 To pain
1 No Response
6 + 5 + 3
= 14
Save
Cancel
Prev Page
Next Page

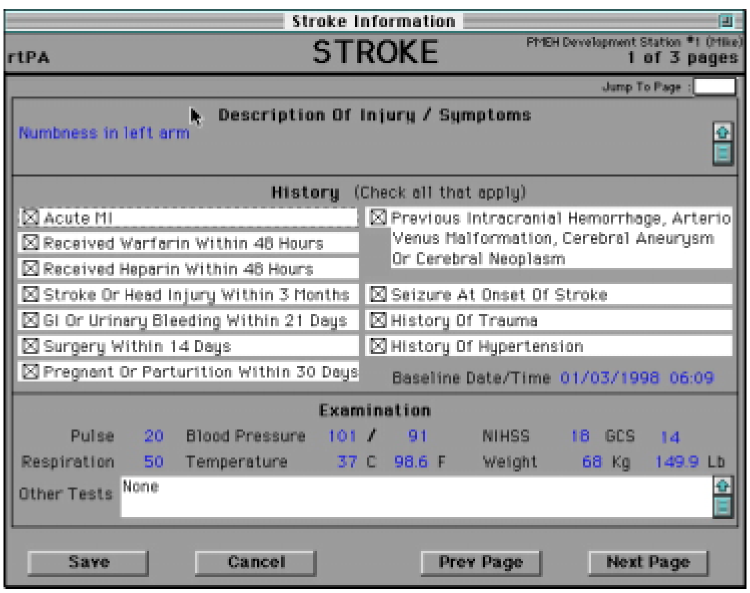

Stroke Information
NIHSS
STROKE
PMEH Development Station #1 (Mike)
1 of 3 pages
Jump To Page :
1a. Level of consciousness 0
0 Alert
1 Not alert, but arousable with minimal stimulation
2 Not alert, requires repeated stimulation to attend
3 Coma
1b. Ask patient the month and their age 1
0 Answers both correctly
1 Answers one correctly
2 Both incorrect
1c. Ask patient to open and close eyes & mouth 2
0 Obeys both correctly
1 Obeys one correctly
2 Both incorrect
2. Best gaze (only horizontal eye movement) 1
0 Normal
1 Partial gaze palsy
2 Forced deviation
3. Visual field testing 1
0 No visual field loss
1 Partial hemianopia
2 Complete hemianopia
3 Bilateral hemianopia (blind including cortical blindness)
4. Facial paresis (ask patient to show teeth or raise eyebrows and close eyes tightly) 3
0 Normal symmetrical movement
1 Minor paralysis
(flattened nasolabial fold, asymmetry on smiling)
2 Partial paralysis
(total or near total paralysis of lower face)
3 Complete paralysis of one or both sides
(absence of facial movement in upper & lower face)
Save
Cancel
Prev Page
Next Page

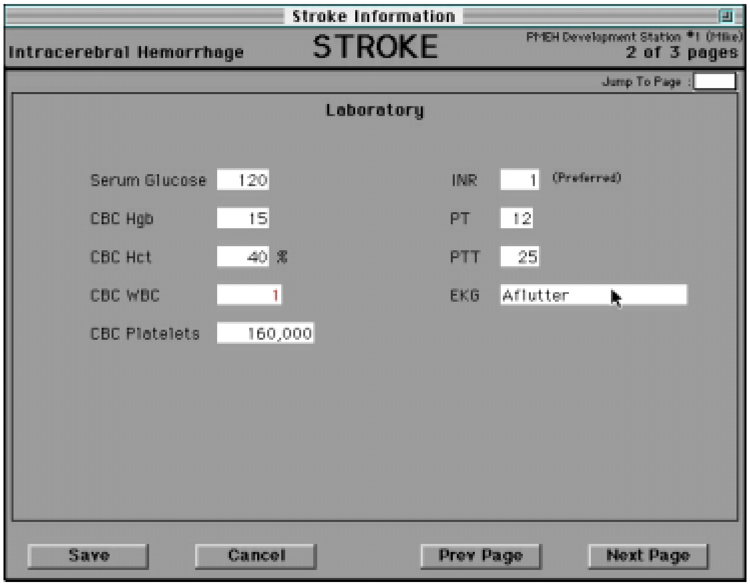

Stroke Information
NIHSS
STROKE
PMEH Development Station #1 (Mike)
2 of 3 pages
Jump To Page :
5a. Motor function right arm 0
0 Normal (extends arms 90 (or 45) degrees for 10 seconds without drift)
1 Drift
2 Some effort against gravity
3 No effort against gravity
4 No movement
9 Untestable (Joint fused or limb amputated)
5b. Motor function left arm 3
0 Normal (extends arms 90 (or 45) degrees for 10 seconds without drift)
1 Drift
2 Some effort against gravity
3 No effort against gravity
4 No movement
9 Untestable (Joint fused or limb amputated)
6a. Motor function right leg 0
0 Normal (hold leg at 30 degree position for 5 seconds
1 Drift
2 Some effort against gravity
3 No effort against gravity
4 No movement
9 Untestable (Joint fused or limb amputated)
6b. Motor function left leg 2
0 Normal (hold leg at 30 degree position for 5 seconds
1 Drift
2 Some effort against gravity
3 No effort against gravity
4 No movement
9 Untestable (Joint fused or limb amputated)
Save
Cancel
Prev Page
Next Page

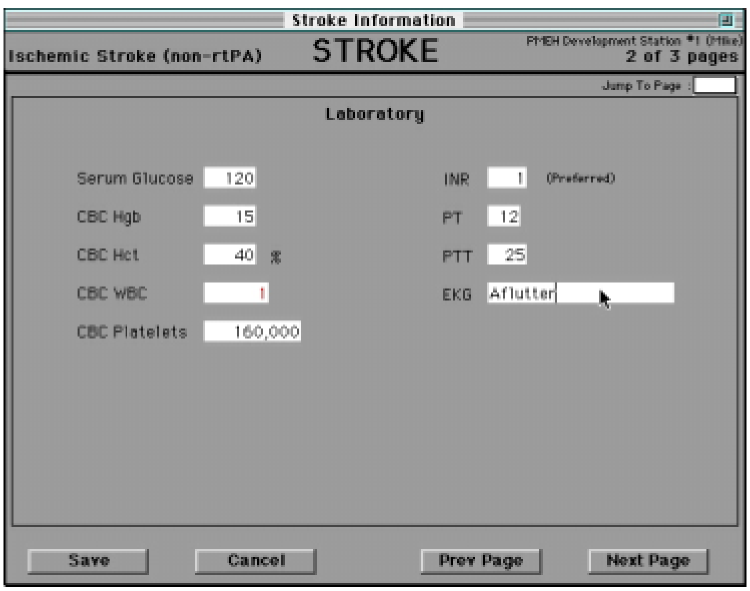

Stroke Information
NIHSS
STROKE
PMEH Development Station #1 (Mike)
3 of 3 pages
Jump To Page :
7. Limb ataxia 1
0 No ataxia
1 Ataxia present in one limb
2 Ataxia present in two limbs
8. Sensory (Use pinprick to test arms, legs trunk, and face - compare side to side) 1
0 Normal
1 Mild to moderate decrease in sensation
2 Severe to total sensory loss
9. Best language (Describe pictures, name items, and read sentences) 2
0 No aphasia
1 Mild to moderate aphasia
2 Severe aphasia
3 Mute
10. Dysarthria (read several words) 1
0 Normal articulation
1 Mild to moderate slurring of words
2 Near unintelligible or unable to speak
9 Intubated or other physical barrier
11. Extinction and inattention 0
0 Normal
1 Inattention or extinction to bilateral simultaneous stimulation in one of the sensory modalities
2 Severe hemi-inattention or hemi-inattention to more than one modality
NIHSS TOTAL 18
Save
Cancel
Prev Page
Next Page

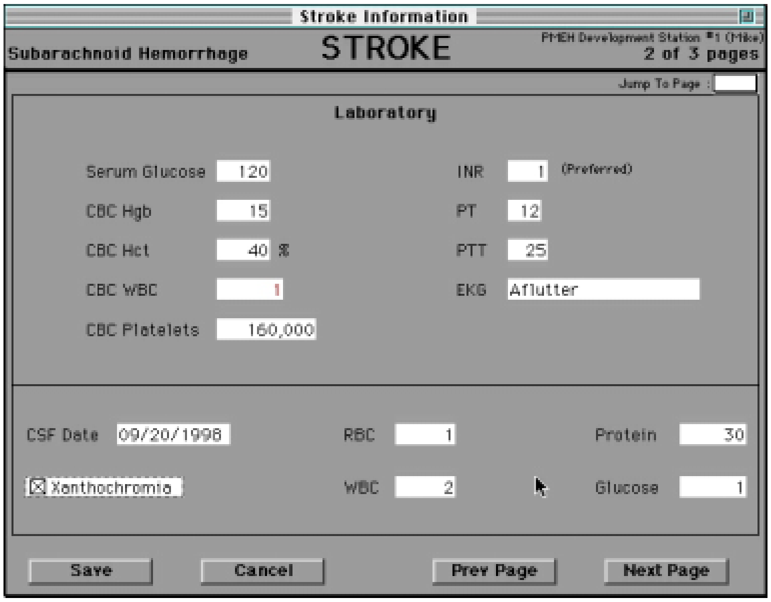

Stroke Information
Intracerebral Hemorrhage
STROKE
PMEH Development Station #1 (Mike)
1 of 3 pages
Jump To Page :
Description Of Injury / Symptoms
Numbness in left arm
History (Check all that apply)
Abrupt Severe Headache
History Of Hypertension
History Of Illicit Drug Use
Seizure At Onset Of Stroke
History Of Trauma
History Of Alcohol Abuse
Loss Of Consciousness
Nausea & Vomiting
Received rtPA Within 24 Hours
Received Wafarin Within 48 Hours
Received Heparin Within 48 Hours
Examination
Glasgow Coma Score 14
Blood Pressure 101 / 91
Pulse 20
Respiration 50
Temperature 37 C 98.6 F
NIHSS 18
Other Tests None
Save
Cancel
Prev Page
Next Page


Stroke Information
Ischemic Stroke (non-rtPA)
STROKE
PMEH Development Station #1 (Mike)
1 of 3 pages
Jump To Page :
Description Of Injury / Symptoms
Numbness in left arm
History (Check all that apply)
Acute MI
Atrial Fibrillation
History Of Trauma
GI or Urinary Bleeding Within 21 Days
Abrupt Severe Headache
Pregnant Or Parturition Within 30 Days
Seizure At Onset Of Stroke
History Of Illicit Drug Use
History Of Hypertension
Examination
Respiration 50
Pulse 20
Blood Pressure 101 / 91
Temperature 37 C 98.6 F
GCS 14
NIHSS 18
Other Tests None
Save
Cancel
Prev Page
Next Page


Stroke Information
rtPA
STROKE
PMEH Development Station #1 (Mike)
1 of 3 pages
Jump To Page :
Description Of Injury / Symptoms
Numbness in left arm
History (Check all that apply)
Acute MI
Received Warfarin Within 48 Hours
Received Heparin Within 48 Hours
Stroke Or Head Injury Within 3 Months
GI Or Urinary Bleeding Within 21 Days
Surgery Within 14 Days
Pregnant Or Parturition Within 30 Days
Previous Intracranial Hemorrhage, Arterio Venus Malformation, Cerebral Aneurysm Or Cerebral Neoplasm
Seizure At Onset Of Stroke
History Of Trauma
History Of Hypertension
Baseline Date/Time 01/03/1998 06:09
Examination
Pulse 20
Respiration 50
Blood Pressure 101 / 91
Temperature 37 C 98.6 F
NIHSS 18
GCS 14
Weight 68 Kg 149.9 Lb
Other Tests None
Save
Cancel
Prev Page
Next Page


Stroke Information
Intracerebral Hemorrhage
STROKE
PMEH Development Station #1 (Mike)
2 of 3 pages
Jump To Page :
Laboratory
Serum Glucose 120
CBC Hgb 15
CBC Hct 40 %
CBC WBC 1
CBC Platelets 160,000
INR 1 (Preferred)
PT 12
PTT 25
EKG Aflutter
Save
Cancel
Prev Page
Next Page


Stroke Information
Ischemic Stroke (non-rtPA)
STROKE
PMEH Development Station #1 (Mike)
2 of 3 pages
Jump To Page :
Laboratory
Serum Glucose 120
CBC Hgb 15
CBC Hct 40 %
CBC WBC 1
CBC Platelets 160,000
INR 1 (Preferred)
PT 12
PTT 25
EKG Aflutter
Save
Cancel
Prev Page
Next Page


Stroke Information

Subarachnoid Hemorrhage STROKE PMEH Development Station #1 (Mike) 2 of 3 pages

Jump To Page :

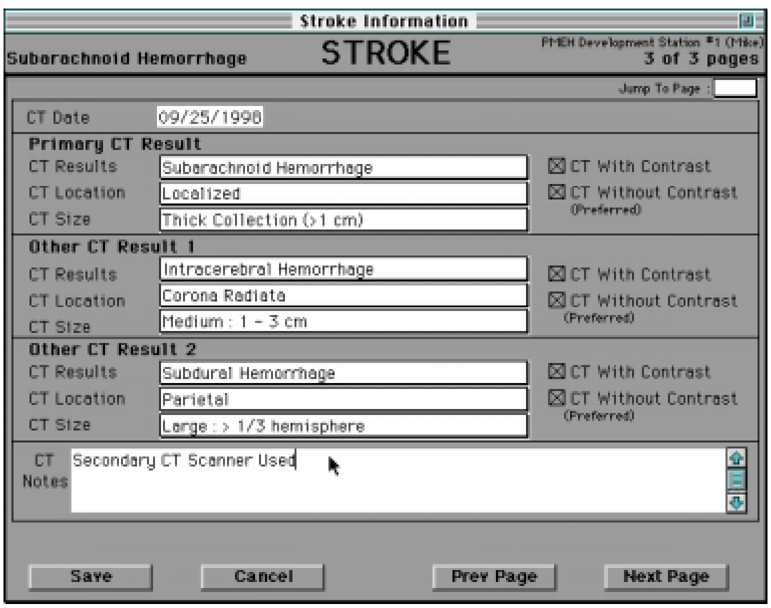
Laboratory

Serum Glucose 120
CBC Hgb 15
CBC Hct 40 %
CBC WBC 1
CBC Platelets 160,000

INR 1 (Preferred)
PT 12
PTT 25
EKG Aflutter

CSF Date 09/20/1998
☒ Xanthochromia
RBC 1
WBC 2
Protein 30
Glucose 1

Save Cancel Prev Page Next Page


Stroke Information

Subarachnoid Hemorrhage STROKE PMEH Development Station #1 (Mike) 3 of 3 pages

Jump To Page :

CT Date 09/25/1998

Primary CT Result
CT Results Subarachnoid Hemorrhage ☒ CT With Contrast
CT Location Localized ☒ CT Without Contrast (Preferred)
CT Size Thick Collection (>1 cm)

Other CT Result 1
CT Results Intracerebral Hemorrhage ☒ CT With Contrast
CT Location Corona Radiata ☒ CT Without Contrast (Preferred)
CT Size Medium : 1 - 3 cm

Other CT Result 2
CT Results Subdural Hemorrhage ☒ CT With Contrast
CT Location Parietal ☒ CT Without Contrast (Preferred)
CT Size Large : > 1/3 hemisphere

CT Notes Secondary CT Scanner Used

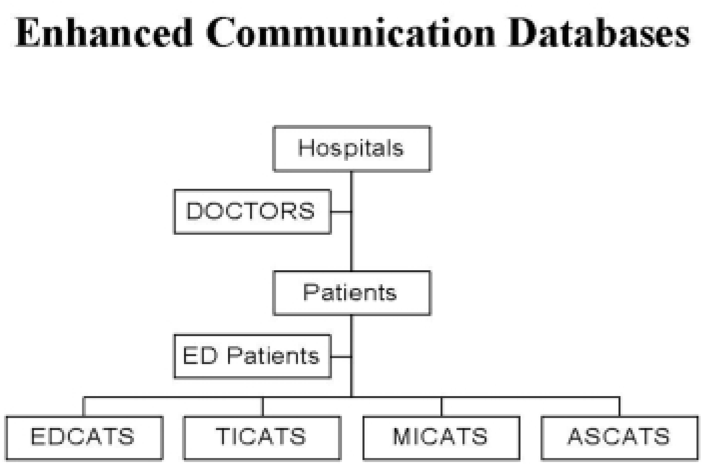
Save Cancel Prev Page Next Page

3) Integration of the software with other data sources and teleconferencing software.

System Description

Configuration

MICATS (Myocardial Infarction Consultation and Triage System) and ASCATS (Acute Stroke Consultation and Triage System) were integrated in to the trauma system (TICATS) that was developed under a prior NLM grant. These form the branches of an integrated emergency medicine system.



The system configuration is based on a relationship between the University of Iowa Hospital and Clinics and many rural Iowa community hospitals. The rural hospitals are connected to the University and the Internet using T1 and frame relay cabling technology. Network connectivity provides a more extensive way to communicate between hospitals, allowing for the transfer of electronic data and video. All rural hospitals were provided with an Apple Macintosh computer, Apple video conferencing camera, Hitachi Mpeg video camera, Elmo overhead camera, Visioneer Paperport scanner, Apple Laserwriter printer, PCMCIA card reader, as well as a few other miscellaneous devices. The University of Iowa Hospital and Clinics was provided with two Apple Macintosh computers, Apple Laserwriter printer, and VCR. Behind the scenes, a Windows NT Server was setup for uploading Mpeg videos, web services, dialup services and the development of a centralized database. A medical consultation is initiated by the rural hospital to the University of Iowa using an electronic database of patient records and a video conferencing session. The rural hospital has the ability to send scanned information, video of a patient, X-ray pictures, as well as patient record data in real time over the network.

Performance

T1 and frame relay network cabling provide cost-effective network bandwidth between hospitals. The electronic transfer of patient record data is very good. Video conferencing sessions are adequate. The Apple Macintosh computers are user-friendly and reliable.

On the other hand, performance is a problem when transferring video clips of patients -- large transfers of data take time. Dialup connections used by University of Iowa doctors from home is extremely limited due to low network bandwidth over phone lines. Hardware failure is a problem. Operator error is the biggest performance problem. Physicians have not yet shown evidence of the willingness or patience for operating the hardware and software.

Security

We are using Versign secure socket layer software to encrypt data transfer between hospitals. The electronic databases are password protected. We perform backups of the Windows NT Server daily during the work week. Backup tapes are located in a secure, fire-proof safe.

4) Test the software and the system and evaluate performance including full-motion video for assessment of the neurological examination.

CT Evaluation

Computed tomography (CT) is a critical component of evaluation of patients with suspected stroke: subtle findings can be missed in an emergency setting. This project evaluated whether the use of telemedicine transmission would result in a decline in the interpretation of CT scans obtained from patients with stroke. Four neurologists and two radiologists independently interpreted 23 CT scans showing a variety of abnormalities with stroke. The examiners first interpreted the scans using videoconferencing software. Two weeks later, each of the physicians interpreted the same scans in a different order using a traditional view box. The quality of the CT image was equal using the view box or the computer. The inherent problem with the computer is the difficulty of examining more than one image at a time. This process slowed interpretation but is still suitable for telemedicine consultation. The average correct score was 95.7% with the computer system and 95.6% with the view box. The intra-rater reliability was 92.2%. For acute ischemic stroke the accuracy was lower with 80% for the computer screen and 86% with view box and the intra-rater score was 81%.

Neurological Examination

This project evaluates the interrater reliability of scoring the NIH Stroke Scale (NIHSS) in patients with acute stroke by videotaping and transmitting the examination for scoring at a remote site as compared to bedside observation. Because there is a need for rapid assessment by a cerebrovascular specialist of acute stroke patients who cannot rapidly reach a tertiary care center, a telemedicine system allowing interactive delivery of care including assessment of the NIHSS is being developed at the University of Iowa.
Twelve patients with acute stroke had an NIHSS (scores ranging from 1 to 13) recorded at the bedside using hand-held digital camera. The movies were viewed at a remote site and scored independently by three neurologists and a neurology resident. These NIHSS ratings were compared to those obtained by the neurologist at the bedside to determine the percent accuracy for each component of the scale. The correlation between all raters was also determined for the overall score. The agreement between the four remote raters was assessed for each component of the NIHSS using a kappa statistic. The accuracy of the components of the NIHSS ranged from 69% 98%. The kappa scores varied from 0.32 (neglect) to 0.82 (sensory). The total NIHSS score was strongly correlated between the remote and bedside raters. ($r=0.88$, $p < .05$).
Conclusions: Digitization and electronic transmission of the NIHSS examination to a remote site does not introduce significant error when compared to bedside scoring. It is feasible to assess the NIHSS in a stroke patient at a remote site using telemedicine.

Accuracy and Agreement for the Components of the NIHSS

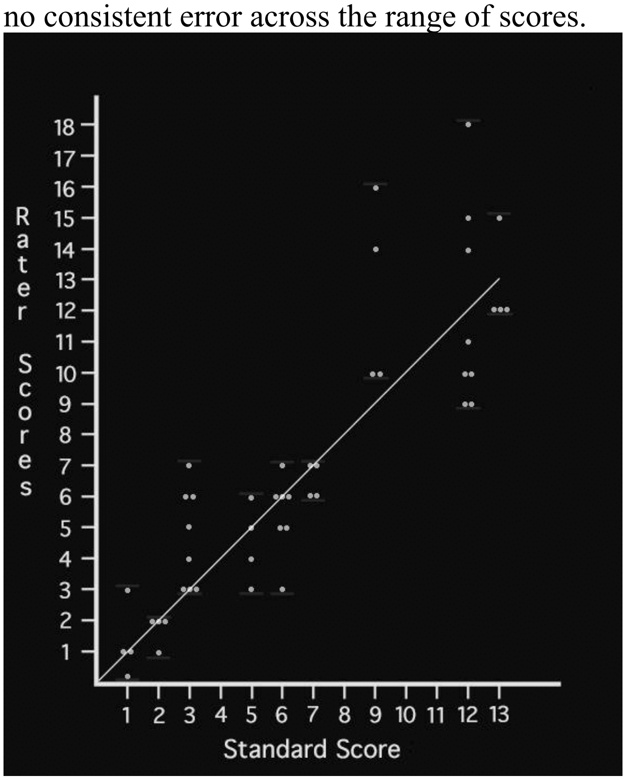
Component	Accuracy (SE)	Kappa
LOC-Alert	94% (0.03)	
LOC-Questions	88% (0.05)	
LOC-Commands	98% (0.02)	
LOC-Combined		0.54
Best Gaze	81% (0.06)	0.35
Visual Fields	96% (0.03)	0.66
Facial Palsy	69% (0.07)	0.58
Motor – Left Arm	77% (0.06)	
Motor –Right Arm	90% (0.04)	
Motor-Arm		0.47
Motor-Left Leg	69% (0.07)	
Motor-Right Leg	81% (0.06)	
Motor-Leg		0.39
Limb Ataxia	83% (0.05)	0.51
Sensory	71% (0.07)	0.82
Best Language	92% (0.04)	0.45
Dysarthria	90% (0.04)	0.62
Neglect	81% (0.06)	0.32

Interrater Reliability of Individual NIHSS Items

NIHHS Item	Current Study (9)	Shafqat et al. (6)	Goldstein et al. (5)	Brott et al.
LOC		0	0.50	0.49
LOC-Orientation		0.75	0.64	0.80
LOC-Commands		0.29	0.41	0.58
LOC-combined	0.54			
Best gaze	0.35	0.41	0.33	0.82
Visual Fields	0.66	0.60	0.57	0.81
Facial palsy	0.58	0.40	0.22	0.57
Motor –arm	0.47	0.82	0.77	0.85
Motor-leg	0.39	0.83	0.78	0.83
Ataxia	0.51	-0.07	-0.16	0.57
Sensory	0.82	0.48	0.50	0.60
Language	0.45	0.65	0.79	0.64
Dysarthria	0.62	0.55	0.32	0.55
Neglect	.32	0.77	0.61	0.58

LOC=Level of consciousness

In the figure below, for each NIHSS determined by the bedside observer (standard score on x axis), the results from the four video raters are plotted (y axis). In cases where two patients had the same score, there are eight observations. The line demonstrates perfect agreement. There is no consistent error across the range of scores.



EKG Evaluation

The purpose of this project is compare scanned, digitized via camera and paper output of EKGs. The evaluators read the EKGs blinded to method of digitization. Preliminary findings show that the EKGs digitized by the camera are not really that sharp and don't seem much better than a simple fax and would probably only be useful to assess only significant EKG changes. The scanned images are clearer and shaper than the camera-produced images. The scans are better even though the color is off a bit and one can get a reasonable idea of rates, intervals, etc. from peering at the grid. A quantitative evaluation of the reliability is in progress.

5) Training

Training was done in site meetings at each hospital. Videotapes were made for NIH Stroke Scale training and testing. Each physician was to view the tapes and pass a NIH Stroke Scale certification exam. On site training was done for each physician for the telemedicine system. Training for the consult physicians were trained on the system in the Emergency Room that had a videoconference and file computers. They were also trained to use computers in their home to retrieve the images and reports from a internet site.

NIHSS Certification

Each physician who would be completing the NIHSS was required to complete the certification process. The physician was required to review the definitions and instructions for completing the scale and then view an educational videotape. The physician then viewed the certification videotape, which contained five patients for the physician to evaluate. The completed forms were sent to the University of Iowa for scoring and certification if they met minimum standards. The physician could also receive Continuing Medical Education Credits for completing the process.

Community Education

Participating hospitals were contacted to determine what educational materials were needed at their hospital. The hospital could request brochures, posters, bookmarks, magnets, and etc. either provided by the AHA, NSA, or the University of Iowa. The hospital used the materials in community functions such as county fairs.

Help Site for Videoconferencing

A help site for use of the videoconference equipment and procedure for a videoconference was put on the web at the following location http://www.public-health.uiowa.edu/edcats/index.html Additional support was made available to each hospital by direct line to the research assistant as well as a pager.

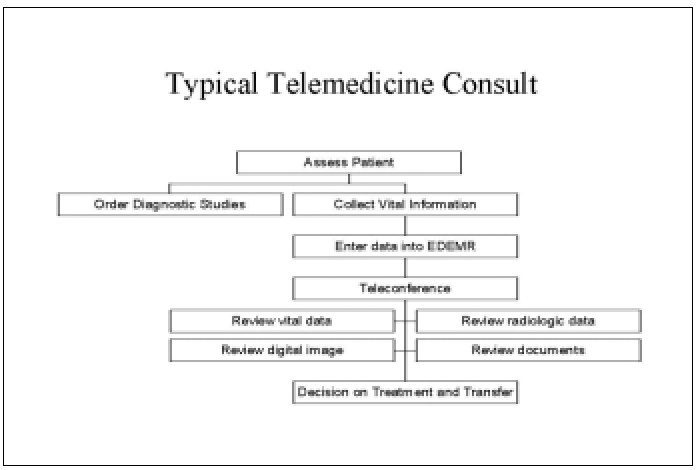
6) System installation on the computers at the 6 participating rural hospitals.

A uniform procedure was developed and implemented to provide for standard software configuration and limited browser access to allow for maximum memory for videoconferencing.

The system was implemented in the emergency rooms with contact made through Physician Consultation Referral Center at the University of Iowa Hospitals and Clinics. Each consultation was to be made with a specialist. Each physician was to evaluate the quality of the consultation.

EDCATS Consult Process

The process for consultation is described in detail in the Attachment to this Report. The consultation is designed to be an integral part of patient care as demonstrated in the following figure.



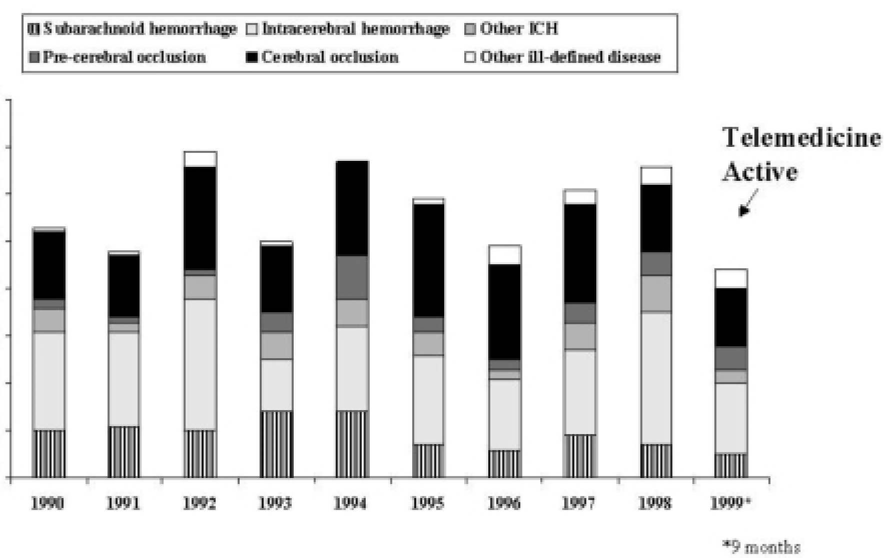
The decision to do the consultation via telemedicine is up to the discretion of the local physician. Because of the urgent nature of the consultation the first contact is by phone. The local physician and the consulting physician can then decide to assess the eligibility of the patient via the telemedicine data transfer and video conference.

7) Use of the System

The system was fully operational in early 1999. Training and operational support were available to all centers. To date there have been no telemedicine consults. However, we have increased the number of ischemic stroke phone calls and early administration of rtPA. Four hospitals have developed acute stroke protocols as a result of our educational visits and NIH Stroke Scale Certification.

The potential for telemedicine use has not changed from prior years with approximately 58 stroke patients being consulted and transferred from the telemedicine hospitals alone. In 1999 there were 44 transfers while the system was operational in 9 months or estimated 58 in the year. There were also 61 transfers for myocardial infarction. Most of these consults were by telephone. Approximately 10 calls were for rtPA administration in stroke patients.

All Cerebrovascular Transfers to UIHC from Telemedicine Hospitals, 1990 - 1999
(Burlington, Grinnell, Keosauqua, Muscatine, Ottumwa, Keokuk, Washington)



Evaluation of the Project

The project resulted in development of a protocol using current clinical guidelines and practices, a means of dissemination of the guidelines and protocol through a conference, websites, local hospital presentations, and a comprehensive integrated database elements and algorithms, an integrated computer system for data transfer of neurologic exam, radiologic images, and clinical vital data, a system that utilizes scanners for paper documents and EKGs, still videocameras for imaging of radiologic films, and hand-held digital cameras for the neurological evaluation, an integrated pathway for consultation using a consultation network, a system of data transfer that provides information via the web which can make the consultation available through internet connections, and an assessment of videoconferencing and digital full motion imaging which still requires high-speed communication lines and computers with enough RAM dedicated to these processes.

The project was successful in building a system and developing a mechanism for consultation. The lack of utilization despite affirmation by local physicians that the system was worthwhile, was a disappointment. Lack of utilization may have been due in part to a (perceived) increase in knowledge and capability of the local hospitals and physicians to manage their own ABI and AMI cases as evidenced by development of local protocols for treatment. Also, the physicians did not incorporate telemedicine into their practice because of infrequent need and use. Presentation of the ABI patient was not frequent enough to make telemedicine an everyday occurrence. There were no financial or contractual incentives for the remote sites to use the system. The local hospitals and physicians didn't view this a part of an established network or organizational relationship and they appeared to feel that they did not have any vested interest in this program. The telephone continued to be the preferred mechanism of communication, despite the fact that less information could be transferred in this way.

Lessons Learned

It is possible to develop a protocol for telemedicine that utilizes national and local guidelines and that these can be translated into a technology-based system.

Technological advances have increased the capability of information transfer including database information of vital statistics, digitized images from camera or scanner, full-motion video of patient examination and videoconferencing for consultation.

Images of CT scans and EKGs can be transmitted and interpreted using digitization, fiberoptic communication and PC or Macintosh platforms.

Full-motion video and audio of the neurological examination is a reliable means of visualizing the patient between remote locations. This technology is not difficult and can be done by ER staff. However the images are in two dimension hence certain aspects of the exam could be enhanced by more than one camera angle.

The use of the system remains a major obstacle to evaluation of its effectiveness. Incentives for participation and reimbursement of care delivered via telemedicine might be necessary for its use.

The current physicians are used to telephone consultation. Future physicians who are more computer comfortable may find this method of communication more acceptable, ie. more information transferred because of technology.

The project accomplished the development and technological implementation of the enhanced communication concept. Without a structured and required pathway for communication or contractual relationship, health care providers utilize easier methods for communication even though they risk miscommunication. Providers perceive the risk for miscommunication small given the urgency and choice of communication methods. Further education on the need for maximizing information transfer is the next step for use.

In summary, we have developed a system consistent with clinical guidelines and practice and its capabilities were as satisfactory for the assessment of the patient. However, use of the system by the physicians was less than anticipated due to development of local protocols for ABI and AMI treatment and choice of consultation medium.

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