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## Rural Telemedicine Project in Northern New Mexico<sup>1</sup>

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### Abstract

*A virtual electronic medical record system is being deployed over the Internet with security in northern New Mexico using TeleMed, a multimedia medical records management system that uses CORBA-based client-server technology and distributed database architecture. The goal of the NNM Rural Telemedicine Project is to implement TeleMed into fifteen rural clinics and two hospitals within a 25,000 square mile area of northern New Mexico. Evaluation of the project consists of three components: job task analysis, audit of immunized children, and time motion studies. Preliminary results of the evaluation components are presented.*

### 1. Introduction

Applications of telemedicine are becoming more ubiquitous as technology evolves to support greater bandwidth, better security and vast amounts of information. TeleMed was developed by the Los Alamos National Laboratory Advanced Computing Laboratory to show how advanced technology could support a multimedia medical records management system over the Internet with security. TeleMed<sup>1,2</sup> forms "virtual patient records" by accessing data from multiple geographically separate locations using the Internet, ordinary computer hardware, state-of-the-art security and a Patient Identification Service (PIDS). TeleMed's virtual patient record displays pointers to diagnostic images, laboratory test results, medication plans, treatment regimens, and a record of current immunizations from a variety of sources and shows this information in a comprehensive, chronological time line. Data is actually retrieved

only on demand, thereby minimizing the bandwidth requirements.

### 2. Overview of Project

Los Alamos National Laboratory (LANL), clinics across northern New Mexico and state Department of Health partners recognized the need for computer-based patient records in this rural area and formed the Northern New Mexico Rural Telemedicine Project, with the institutional support of Northern New Mexico Community College. The project, funded by a Department of Commerce (DOC) National Telecommunications and Information Administration (NTIA) grant, officially began in 1997. The goal of the project is to implement a LANL-developed prototype telemedicine system, TeleMed, into eighteen rural clinics and hospitals in the northern New Mexico region. The project will initially focus on the following goals: increased immunization rates, decreased incidence of lost, misplaced or duplicate patient records and improved communications between clinics of current medications and lab test results. Extensions to patient encounter information will be added at a later date.

In order to successfully deploy TeleMed to these rural clinics and hospitals the sites were surveyed (Table 1). The clinics and hospitals are found at elevations ranging from 5,000 to 8,000 ft. in the mountainous terrain of northern New Mexico, spread over an area of approximately 25,000 square miles.<sup>3</sup> In the winter, roads often become packed with snow. As the table shows, many of the clinics are open only two days per week. If an illness or emergency arises, patients must travel to the next available clinic, which has no record of the patient's medical history,

<sup>1</sup> Supported in part with a grant from the National Telecommunications and Information Administration of the Department of Commerce and the Department of Energy.

**Table 1-Clinical Demographic Information**

<b>Clinic</b>	<b>Location</b>	<b>Average Number of Patients/Day</b>	<b>Days Open</b>
Health Centers of Northern New Mexico	Chama	6	Mon-Fri
Health Centers of Northern New Mexico	Coyote	17	Mon, Wed, Fri
Health Centers of Northern New Mexico	Embudo	19	Mon-Fri
Health Centers of Northern New Mexico	Española	58	Mon-Fri
Health Centers of Northern New Mexico	Highlands	13	Mon, Tue, Thu, Fri
Health Centers of Northern New Mexico	La Loma	13	Mon, Wed, Thu
Health Centers of Northern New Mexico	Las Vegas	38	Mon-Fri
Health Centers of Northern New Mexico	Penasco	26	Mon-Fri
Health Centers of Northern New Mexico	Roy	17	Tue, Thu
Health Centers of Northern New Mexico	San Miguel	15	Mon-Fri
Health Centers of Northern New Mexico	Springer	13	Mon-Fri
Health Centers of Northern New Mexico	Truchas	15	Tue, Thu
Health Centers of Northern New Mexico	Wagon Mound	12	Wed, Fri
Las Clinicas del Norte	Abiquiu	10	Mon-Fri
Las Clinicas del Norte	El Rito	10	Mon-Fri
Las Clinicas del Norte	Ojo Caliente	17	Mon-Sat
Española Hospital	Española	125	Mon-Sun
Los Alamos Medical Center	Los Alamos	26	Mon-Sun

medications, allergies, lab test results, etc., that reside in the paper-based record at other clinics in the region. Thus, an electronic medical record system has the potential to increase quality of care by improving communications between the clinics.

### 3. The TeleMed System

TeleMed is designed as a distributed object system in which the various healthcare components are dealt with as objects and distributed via the Common Object Request Broker Architecture (CORBA) standard. Java has been used to implement both the client and server side to facilitate portability and ease of development. In its current configuration, there are at least three servers that must be connected. The first is the authentication server that validates the user and manages the access policy for various servers. The second is a Person Identification Server (PIDS) that utilizes a variety of demographic information to uniquely identify a patient who is the subject of treatment. Following successful identification of the patient, the client connects to a MedLib server that provides the relevant clinical information for that patient. There might be multiple MedLib servers feeding information to the client.

All of the patient demographics is located on the PIDS server which is separate from MedLib. The goal of PIDS is to provide a standard method of locating person identifiers and their associated records across facilities and enterprises, subject to the confidentiality concerns and the right for anonymous care. By separating the two servers a breach in security would not reveal pertinent information because a name or identity will not be associated with the medical data.

PIDS provides for a flexible set of traits that can be matched with varying quality as well as providing for correlation of person identification across multiple domains. Traits might include, for example, social security numbers, telephone numbers, zip codes, and even searches on photos of patients who "look like this patient." TeleMed implements this standard so that multiple, diverse systems can be linked together for patient location information.

Access to patient records will still be regulated by the institution creating the record. This measure of security offers the clinical site the opportunity to protect their original patient data. This system allows for the ownership of medical data to remain with its creator and aids in the control of access to confidential information.

### 4. Security of the TeleMed System

TeleMed has incorporated a security system that makes it possible to model the complexity of varying roles of healthcare providers in how they access medical data. The architecture uses public/private key infrastructure in both hardware and software. The philosophy is to keep all of the user identification, passwords, and access policies on the server side and expose as little as possible directly in the interface to the PIDS. Maintaining privacy and confidentiality when electronic information systems make data much more accessible is of primary importance [4]. Along with the authentication, every server (including the authenticator) is expected to manage the policies of its data and a user list class is provided to implement policies, along with a simple encryption class for rudimentary secure communications.

### 5. Evaluation of TeleMed

Throughout the project a variety of evaluation strategies are being used to assess the overall effectiveness of the TeleMed system in a rural health care setting. At the beginning of the project an evaluation plan was devised that incorporated the following evaluation strategies: a job task analysis, audits of immunizations, and time motion studies.

#### *Job Task Analysis*

Job task analysis is an analytical method that uses focus groups and written questionnaires to determine performance standards necessary to successfully execute a set of activities. In order to analyze the impact of TeleMed in rural health care settings, the focus groups and questionnaires were performed before any changes to the currently used paper-based system and will be repeated after TeleMed is in place. Two focus groups were assembled, consisting of representative medical record keepers in one case, and providers in the other. The purpose of these focus groups was to identify and rank current problems with patient records, determine possible solutions to the current problems, and establish success criteria for the TeleMed system. Each focus group was asked to follow a specific protocol. First, the group would either brainstorm or carry on a building discussion to generate new ideas. Next, a roundtable discussion occurred to allow participants the opportunity to clarify points already addressed. Finally, the group was asked to prioritize the list generated based on a simple vote.

**Medical Records Keepers** The first focus group consisted of medical record keepers and occurred in September 1996. The top five current problems with patient records, according to this focus, were as follows:

**Table 2. Medical Records Keepers: Problems with Paper-Based Patient Records<sup>5</sup>**

1. Having the records in the right place when they are needed
2. Communicating across organizations (i.e. getting lab results accurately and quickly)
3. Coordinating records to make sure the most recent information is available and the record is complete
4. Positive ID of patient's records
5. Multiple records of same patient in different places

The participants of this group suggested that making medical records more easily accessible from a variety of sites, as well as, communicating among those sites would alleviate a majority of the current problems. The most obvious need for this group is for *administrative information*, such as a patient's birth date, address and billing information. Successful implementation of PIDS for the medical records keepers will be an important aspect of how this group views the success of the TeleMed system.

**Health Care Providers** The second focus group consisted of medical record users, the health care providers, and occurred in December 1996. The top five current problems with paper-based medical records or potential problems of a computer-based system according to this group of providers are summarized in Table 3. A major concern of the providers with an electronic medical record system involved security and confidentiality. This group would consider the system a success if it could provide a more efficient means for accomplishing tasks without sacrificing security and confidentiality.

**Duties and Tasks** As a final portion of the job task analysis each focus group was asked to follow a specific procedure to generate topics for a written questionnaire. First, the group listed all the duties associated with their job. Next, group members generated a list of the major tasks for each duty that must be completed in order to perform that duty properly. Finally, any

pertinent sub-tasks were added to the list of tasks or duties. The final list of tasks or duties was used as the basis for the written questionnaire.

**Table 3. Health Care Providers: Problems with Paper-Based Patient Records<sup>6</sup>**

1. Cannot access basic information easily (i.e. allergies, immunizations, past histories, medications, surgical procedures)
2. Inability to determine in a timely manner what is covered by insurance (i.e. which lab tests are covered or which doctors participate in the patient's health plan). In addition, as health plans change, clinics may not be informed until they try to use the plan to refer a patient and find that the patient's plan will not cover the referral.
3. Transfer of information from one clinic to another is slow and labor-intensive.
4. Difficult to get information necessary to qualify patients for financial assistance.
5. No feedback on results of medical practice (i.e. medical treatment failures, readmissions, compliance failures, etc.)

The written questionnaire was used to assess the frequency, difficulty, time spent, and consequences of performance of the various duties in order to determine potential job performance areas that TeleMed might facilitate. The medical record keepers reported that creating new patient records was the most frequent activity, creating aggregate reports was the most time consuming and difficult activity, and summarizing individual patient records was the most consequential activity. The providers reported that patient interactions and documentation of those interactions were the most frequently performed and time consuming activities while following up on patient progress was the most difficult and consequential activity.

#### *Lost, Missing or Duplicate Patient Records*

Our evaluation strategy included documentation of the instances of duplicate records and the number of lost or misplaced records. During 62 hours of observation there were no instances of multiple records; seven charts were labeled by a staff member as missing or misplaced. This number is statistically small, considering that hundreds of records were accessed during that time period.

### Immunizations

A major focus of the project is the documentation of immunization records. The impact of TeleMed on the timely immunization of all children 0-2 years old will be assessed through CASA, a software application created by the National Immunization Program of the Centers for Disease Control. An initial CASA assessment was done in May 1997. From this data collection we found that 221 children in the 0-2 year-old range visited the clinics during the immediately preceding two years. Of that number, 39-55% received immunizations (see Table 4). This, however, does not account for children receiving vaccines elsewhere, such as from public health offices, schools, etc. It is, however, a measure of how many children visiting the clinics receive immunizations.

The first three vaccines listed are required for 2-year-old children and the last two are recommended vaccines. However, the hepatitis series is expected to become a required vaccine within the next two years. The New Mexico Public Health Department (PHD), as a partner in the project, will provide a PEDS server containing data on all live births in the state, data which is now routinely collected by the PHD. As children visit the clinics, their immunizations will be posted to the TeleMed record. Simple alerts to the care giver that a particular immunization is either due or overdue will assist clinics in providing the immunizations on a timely basis. Post-TeleMed data will be collected once a stable implementation is achieved and the results will be compared with the pre-TeleMed findings.

**Table 4: 1997 Clinical Assessment Software Application (CASA) Results**

Clinical Sites	Total # of Children Visiting Clinics	DTP4 OPV3	MMR1	HEPB3 HIB3		
Health Centers of Northern New Mexico(9 clinics)	176	77	106	83	108	98
Las Clinicas del Norte(3 clinics)	45	10	16	18	16	11
<b>TOTALS</b>	<b>221</b>	<b>87</b>	<b>122</b>	<b>101</b>	<b>124</b>	<b>109</b>
<b>PERCENTAGES</b>		<b>39%</b>	<b>55%</b>	<b>46%</b>	<b>56%</b>	<b>49%</b>

DTP4: Diphtheria, tetanus, pertussis

OPV3: Oral polio vaccine

MMR1: Measles, mumps, rubella

HIB3: Haemophilus influenzae Type B

HEPB3: Hepatitis B

### Time Motion Studies

A final strategy used to evaluate the impact of the TeleMed system in rural health care settings involves a series of time motion studies. A time motion study entails documenting all of the activities and movements of a subject, as well as the time spent performing each of these tasks, for a predetermined time period. In order to obtain this data a research assistant visited the three rural clinics of Las Clinicas del Norte and

the Los Alamos Medical Center Emergency Room over a period of several weeks in June-July 1998. At each of these clinical sites the researcher followed a receptionist/medical record keeper, nurse or provider for three hours continuously and documented the subject's movements on a floor plan of the site, as well as timed each activity with a stop watch. A total of 62 hours of observations was achieved. All of this raw data was grouped, analyzed and ranked to determine which activities are the most time

consuming. TeleMed's final design will attempt to target those activities that can positively impact the users' tasks according to the priorities identified in the focus group sessions.

Our preliminary analysis examined only the activities of the health care providers in the rural clinics. We grouped the activities into 9 categories: 1. Patient interactions (time in the exam room, telephone conversations, etc.); 2. Medical record interactions (review record, create notes, medications, dictations); 3. Interactions with other staff members (preparing for the patient, discussing the patient); 4. Pharmacy activities (getting medications, stocking supplies); 5. Phone calls (about patients, other); 6. Reports and correspondence; 7. Billing documentation; 8. Continuing education; 9. Other. A summary of our results of 20.4 hours of observations of health care providers is shown in Table 5.

**Table 5. Health Care Providers:  
20 hours of Time Motion Studies**

Patient interactions	39%
Medical record	21
Other staff	12
Pharmacy	8
Phone	5
Reports	2
Billing	1
Continuing ed	9
Other	3

This data largely validated the results of the focus group sessions. Not surprisingly, patient interactions dominate the health care providers' time (39%). Medical record interactions occupied 21% of their time. Breakdown of this category showed that 19% of this time is spent reviewing the record getting ready for the patient; 34% documenting the patient encounter; and 48% dictations. Interactions with other staff members showed that 16% of the time in this category was spent in preparing for the patient encounter and 80% discussing the patient with other staff (pharmacists, social worker, scheduling appointments, etc.) Pharmacy activities are the actual mechanics of providing medications to the patient and will not be changed with an electronic medical record. Phone calls were infrequent as were reports and billing. The relatively small amount of time spent in reports is more a reflection of the timing of our observations and not necessarily an accurate

picture over a year's time. Focus group analysis showed that the providers are very concerned about being able to generate aggregate reports for quality assurance reviews, which occur on a regular, but infrequent schedule. An electronic medical record system has the potential to provide a very real service in this area.

## 6. Conclusions

We are exploring a variety of strategies to document the impact of an electronic medical record system in a rural setting. We believe that the health care provider is the primary user of the system as an information source for providing more timely and accurate data about a patient's current medical problems and requirements. Medical records keepers need more accurate methods of identifying patients and linking their records between clinics. Both groups need to be able to track and enter data from multiple sources.

The TeleMed system has the potential to impact clinical activities in the following ways: improved patient identification, timely sharing of patient encounters between clinics and capability to aggregate data across multiple patient records. Its acceptance in the clinic, however, will be dependent on its ease of use, accessibility by the different users and its reliability. We expect to show that access to an electronic medical record system will increase the incidence of properly immunized children in the 0-2-year-old range.

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