Bench to Bedside and Beyond: Building and Testing a Regional Telemedicine
Testbed

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The University of Washington with regional missions in both healthcare and education proposed the creation of a telemedicine testbed to evaluate the current and future impact of the National Information Infrastructure on healthcare across the five-state WWAMI region. This testbed was intended to extend the findings from the successful IAIMS program "beyond the walls" of the University of Washington into the remote/rural practice sites of WWAMI. Bench to Bedside and Beyond was thus designed not only to replicate as much as possible the IAIMS toolkit that was successful at the University of Washington and to extend teleconsultation services but also to evaluate those newer models of information and care delivery. We proposed an ambitious set of goals including:

1. Demonstrate televideo consulting capabilities that promote ease-of-use, integration into user workflow and features of a graphical interface that is integrated with the overall UWAMC interface and evaluate the impact.

2. Develop key infrastructure components and extend the infrastructure to selected affiliated partners across the five WWAMI (Washington, Wyoming, Alaska, Montana, Idaho) states.

3. Go beyond televideo consultation by extending access to academic information resources including full-text journals, textbooks, decision support-software tools, Medline and a variety of other clinical and educationally useful information resources and evaluate the impact.

4. Continue development and assess impact of a uniform graphical user interface based on existing data standards to bring together, from the caregiver's perspective, required databases including the electronic medical record, databases and information resources and services

5. Construct and evaluate a model for archiving images -- using compression in the transfer of images and application of new and emerging health data standards including HL7, DICOM in image transfer.

6. Evaluate the impact of a focused integration of data to and among public health practice and clinical practice sites.

7. Review appropriate evaluation research methods and apply them as appropriate throughout the research projects.   Develop additional evaluation strategies as appropriate.

While the original proposal included all of the areas above as well as core infrastructure for secure communications and more in-depth domain specific evaluations of teleconsultation, during the contract negotiations the budget was cut by more than 50%, thus the project was necessarily scaled back.

1. Demonstrate televideo consulting capabilities that promote ease-of-use, integration into user workflow and features of a graphical interface that is integrated with the overall UWAMC interface.

Background: A low-bandwidth rural telehealth network was created in 1994 in the Washington-Wyoming- Alaska-Montana-Idaho (WWAMI) region with the intent of providing specialist services to patients in areas where there is little or no local access to medical specialists. Specialist consultants met via video-teleconference (VTC) with patients and their primary care providers from eight rural sites in the region. The network was established originally with funding from the Federal Office of Rural Health Policy (FORHP). Additional support from the National Library of Medicine (NLM) funded the network between 1996 and 2000.

The purpose of the project was to demonstrate and evaluate the functionality of, and level of satisfaction with, an affordable low bandwidth teleconsultation system. The units used in the rural sites consisted of a PC, video camera, stethoscope, fax machine, digital camera, modem, software, and in some cases a digital scanner. The units had VTC and "store and forward" capabilities. Connection to the UWMC was over paired "switched-56" and ISDN lines, relatively low bandwidth connections. Most rural sites do not have affordable access to the T-1 lines that would be necessary for very high quality sound and video output. While sound quality in such a system is generally unproblematic, the video image is occasionally pixilated and somewhat low-quality at the reception site. In this summary, we report on the satisfaction levels of consultants, local primary care providers and patients with this low-cost, low bandwidth system.

Methods: We used survey instruments to evaluate the experiences of consultants, local primary care providers and patients with inter-active video teleconsultation. In the consultations reported on here, the store and forward capabilities of the system were only used to augment live teleconsultation (by, for example, forwarding a digital image of a lesion prior to a scheduled dermatology consult). We asked each consultant, local primary provider and patient to complete and evaluation form at the end of each consult. The consultant and local provider instruments were similar, asking each provider about the purpose of the visit, the overall quality of the clinical encounter, and levels of satisfaction with various aspects of the encounter. Providers were also asked to compare the VTC experience to other types of consultation (such as phone consultation). Patients were asked to comment on their comfort level with the VTC visit and whether, after experiencing a teleconsultation, they preferred an out-of-town visit to a consultant or the telehealth visit. Patient survey instruments were available in both English and Spanish versions. There were 193 interactive video consults between 1995 and March, 2000. Surveys were completed by patients for 170 of the visits, by local providers for 182 visits, and by specialist consultants for all 193 visits.

Results: The majority of the consultations (68 percent) were for diagnosis and treatment, according to both consultants and local providers. Very few of the visits, 2.1 percent, were in response to medical emergencies. Consultants said that 95.7 percent of the teleconsultations were medically indicated. After the consultations, local providers were able to treat 71.8 percent of the patients themselves. Local providers indicated that without the teleconsultation, at least 47 percent of the patients would have been referred to non-local consultants. The specialist consultants reported that 90.3 percent of the teleconsults prevented a non-local visit for the patient. In the view of local providers, 75 percent of the teleconsults prevented non-local visits.

Among consultants, 67.2 percent indicated that they were "very satisfied" with the overall quality of the clinical encounters; an additional 24 percent were "somewhat satisfied." Among local primary care providers, 95.7 percent were "very satisfied." Consultants and local providers overwhelmingly agreed that the teleconsult experience resulted in "much better" or "better" care than a telephone only consultation (68 percent among consultants, 99 percent among local providers). Compared to an in-person consult, most consultants believed that the teleconsult resulted in the same quality of care (56 percent) or better quality of care (23 percent) for the patient. While providers of both types were generally satisfied with the quality of the teleconsultation experience, they were somewhat less satisfied with the quality of certain aspects of the consult, especially the quality of the video images. Consultants were the least satisfied in this are with only 43 percent saying the quality of the video image was "very good." An additional 28 percent said image quality was "good."

Like the providers, patients were very happy with their telehealth experiences. Some 92.6 of the patients indicated that they preferred the telehealth consult to traveling out of town for an in-person visit with a specialist. Like the consultants, the patients generally liked having their primary provider present for the consult. 77.8 percent of patients rated the overall quality of care they received in the telehealth consult as "very good." An additional 18.8 percent rated it as "good."

Discussion: This affordable, low-bandwidth telehealth network generated very high levels of satisfaction amongst consultants, local primary care providers and patients. Non-local visits appear to have been avoided through use of this network and quality of care, in the view of all three groups, has not been decreased. The results of this study suggest that teleconsultation can be a useful and effective way to deliver specialist services in remote rural areas without access (financial and/or technical) to high-bandwidth digital networks. An important finding is the fact that initially anticipated/perceived usage levels overestimated the number of actual consultations requested/required. This suggests the price of VTC systems and more importantly bandwidth will need to drop before broader unsubsidized (non-grant funded) VTC becomes mainstream in isolated sites of practice.

2. Develop key infrastructure components and extend the infrastructure to selected affiliated partners across the five WWAMI (Washington, Wyoming, Alaska, Montana, Idaho) states.

Background: Specialists at the University of Washington interested in participating in domain specific evaluations of store/forward telemedicine collaborated with the telemedicine evaluation and technical teams to develop specifications for a store/forward teleconsultation system with integral support for evaluation. Specifications for the system included: a) user configurable domain specific templates (both templates for consult requests and templates for evaluation study forms), b) support for on-call and cross cover specialists, c) tracking and auditing of form and consult completion, d) storage of discrete data elements from forms in coded format for statistical analysis, e) support for multiple image formats, f) Web based client interface for primary care providers and specialists, g) integration into diverse workflows, h) protection of patient privacy, i) open source for ease of transportability to other sites. A system was built to these specifications using a Windows NT architecture, IIS Web server, SQL server, Active Server Pages, sever side COM objects, and SSL encryption. XML templates provide a readily configurable user interface that can easily be tailored for domain and study specific requirements.

Methods: We built a system to meet the requirements outlined above.

The system is designed to be table and form driven. The administrator can add new specialists and/or specialties as well as change who is "on call" for teleconsults using the systems Web based administration tools. Both consult and study forms are encoded in a simple XML notation

that includes tags for free-text entry, "pick one of list", "pick multiple off list", "select value in range". For maximum flexibility the system allows images in the common standard image formats permitting the primary care providers to use a variety of digital cameras.

At the UWPN Factoria site for the evaluation study (and subsequently other UWPN sites for an expanded study) the templates were customized to integrate with the EPIC electronic medical record system. Specifically templates were developed for the EPIC system that used extracted information from the EPIC system for incorporation into the store-forward teledermatology template developed by the dermatologists at the UW.

Results: At the time of preparation of this abstract accrual of patients into the evaluation of urban store-forward teledermatology has completed and final analysis of the results is underway. 65 consults were requested by 5 clinicians (including a physicians assistant) over a 22-month period (an average of 3 consults per month). The following is a preliminary analysis of the data. The average time to prepare a teledermatology consultation was 13 minutes. On an 11 point Likert scale (0=Not Necessary, 10=Essential) the primary care providers rated the necessity of the consult as 7 on average. Prior to the teledermatology consult the primary care providers' confidence in their diagnosis and treatment plan were 5.5 and 5.7 on average on a similar Likert scale. There were issues with familiarity and experience taking photographs of dermatological lesions despite training and a "crib sheet" but these issues improved over time as the primary care providers and dermatologists interacted with one another. The preliminary analysis of the dermatologist's assessment of need for further in person contact with the patient suggests a bi-modal distribution with approximately 40% of the time feeling an in-person visit was necessary despite the teleconsultation. The consultation raised the primary care providers' confidence in the diagnosis and treatment plan to 7.9 and 8.2 respectively. Overall satisfaction with the process was 8.7 on a Likert scale (ranging 0=Very dissatisfied and 10=Very satisfied). On a scale from 0=Much worse to 10=Much better the average quality of the teleconsultation process as compared to an in-person visit was rated as 6.5.

Discussion: The XML based configurable store-forward telemedicine system developed at the UW was successfully applied to a real world evaluation study of the potential role and utility of store-forward teledermatology as an adjunct to in person referral in an urban setting. Based on the high user acceptance of the tool (by both primary care providers and dermatologists) and similar preliminary results from users in rural areas it appears this model could be extended to evaluation studies in of store-forward telemedicine in other clinical domains. Preliminary analysis of the results of the urban store-forward teledermatology study suggests it plays a role as an adjunct to in person referral in an urban setting but in a setting where in person visits are readily available it does not obviate the need for a significant number of in person referrals (approximately 40% of the time).

Secure clinical e-mail: We originally proposed to extend a pilot project developed at the University of Washington (Tarczy-Hornoch, P., Goldberg, H.I., Fuller,S., *Design and implementation of integrated encrypted EMAIL for clinicians.* Jour Amer Med Inform Assoc, Fall Symposium Suppl., 1996: p. 850.) which extended the UW developed PINE e-mail system with the addition of PGP encryption. This system worked well in alpha and beta testing but two problems were identified in moving to a production environment for use with physicians in our regional testbed. The first was that unless an SSH telnet connection was used on a PC or Mac then the encrypted e-mail messages were transmitted across the network in plaintext (encryption/decryption of the e-mail message itself taking place on the server). Though this problem was surmountable on PCs and Macs it was not surmountable on X-terminals. Also it involved installation of client software on the systems of the e-mail users which was problematic for our remote rural sites. The second problem with the PGP/PINE solution was that there were no good tools for integrated keyring maintenance and as the keyring got large performance became unacceptable. As a result we explored PGP and S/MIME integrated with Outlook/Outlook Express/Netscape Messenger. The critical problems we identified here were that these systems assume a) the computer with the e-

mail client is secure, b) the computer with the e-mail client is used by only one user or is an NT box with separate user accounts, c) the users use one and only one system to check their e-mail. Since clinicians at our rural sites share computers and use multiple computers and are not running Windows NT this was not a viable solution. The most critical aspect was that a users private key was stored on the hard drive in an only semi-secure fashion and there was/is no provision to allow a user to store their key on the multiple systems they would want to use to check e-mail (nor is there a good way to store their private keys on a central server securely). The most promising technology is still maturing and appears to be Web e-mail clients that establish an SSL connection, then authenticate/authorize users with e-mail stored encrypted on a central server along with private key and with decryption taking place at the time of reading of the message. Another potential technology we are monitoring is the Microsoft Outlook plug in software that uses a central server to store encrypted e-mail messages that are time stamped with an expiration (auto-destruct) date. This is less optimal since again it ties users to a particular e-mail client with a plug-in. In summary encrypted e-mail for clinical use is not at a point yet where it is widely deployable to rural sites that do not have IT support (and similarly not deployable on an open standard basis to patients in these areas). The industry and standards are rapidly evolving and we anticipate that good robust solutions will soon be available.

3. Go beyond televideo consultation by extending access to academic information resources including full-text journals, textbooks, decision support-software tools, Medline and a variety of other clinical and educationally useful information resources and evaluate the impact.

The breadth and depth of electronic knowledge resources have increased dramatically in the last decade. Costs of access to these resources for rural healthcare providers have been rapidly decreasing as well. A number of studies have shown significant information deficits among rural providers and rural providers indicate a high level of demand for library services, ostensibly to alleviate these information deficits. It is not clear, however, if this demand is either being met or if the demand itself is an accurate representation of future use. In this study we identified and assessed the differences between stated demand and actual use in a population of rural providers in the Pacific Northwest.

We discovered that rural providers state a high level of demand for these resources, yet when they are made available, providers use them infrequently. There are parallels to this in our finding of actual vs. anticipated usage rates of teleconsultation. Simply making them available maybe insufficient to generate use or satisfaction. In addition, the types of electronic resources provided by the typical large, university-based health sciences library may not fully address the range of information needs facing rural providers. While most studies of electronic knowledge resources focus on ease of access, it may be that a better understanding of value (real and perceived) may be more illuminating. (See Appendix B for article by Dr. David Masuda et al which reports the key findings from this study.)

4. Continue development and assess impact of a uniform graphical user interface based on existing data standards to bring together, from the caregiver's perspective, required databases including the electronic medical record, databases and information resources and services

Background: Over the past eight years, UW Medical Centers (University of Washington Medical Center and Harborview Medical Center) have created a clinical data repository, MIND, which combines in a distributed relational database information from multiple departmental databases. MINDscape provides a platform independent, dynamic web browser view of the MIND database that is integrally linked to other resources on the Internet including PubMed and the Federated Drug Reference. There are over 10,000 MINDscape user accounts. The weekday average number of hits to MINDscape is 35,302 and weekday average number of individual users is 1252.

DICOM images from multiple Web servers are now being viewed through MINDscape. See Section 5 below for further details regarding this imaging work.

Methods/Results/.Discussion: The exchange of consistent, timely, and high quality communication has historically been a problem between referring and consulting physicians. This study examined the effect of a Web-based patient medical record on improving communication between these two groups. We surveyed 256 community physicians referring to the University of Washington Medical Center (UWMC). Our survey found that our study population was composed mostly of physicians who were satisfied with the follow-up information they received from the UWMC. It was not surprising, therefore, that few in this group adopted U-LINK/MS to follow their patients (20% user rate). As our study population of physicians using U-LINK/MS was small, we were unable to conclude that our system improved referring physician and consulting physician communication. The results of our study do imply that in physician populations where communication is perceived as a greater problem, systems similar to U-LINK/MS will become helpful tools in the near future. (See Appendix B for article reporting the results of this study.)

5. Construct and evaluate a model for archiving images -- using compression in the transfer of images and application of new and emerging health data standards including HL7, DICOM in image transfer.

DICOM images from multiple Web servers are now being viewed through the MINDscape electronic medical record (EMR).

We have implemented five commercial Web servers from three different vendors that act as DICOM Storage Service Class Providers to our computed radiography, computed tomography, digital fluoroscopy, magnetic resonance, nuclear medicine and ultrasound scanning modalities. These DICOM images can be accessed through web URLs or through linking the image server databases using ODBC or SQL gateways. This allows the use of dynamic HTML links to the images on the DICOM Web server through CGI queries from MINDscape, so that radiology reports already resident in the MIND repository can be married with the appropriate images on the DICOM Web servers through the unique examination accession number generated by our Radiology Information System.

DICOM images from multiple DICOM Web servers are displayed with associated exam reports for referring physician and clinicians anywhere within the widespread academic medical center and to radiologists for teleradiology. A main goal in this effort was to provide a single sign-on authentication solution for MINDscape and associated clinical department Web servers. Our institution has implemented an authentication system (MCIS cookies), which are encrypted using a 1024-bit symmetric, private key. The encrypted cookie, associated patient text and image data is then strong encrypted (RSA 128-bit key) and encoded using S-HTTP/SSL for easy transport and compliance with HIPAA guidelines.

Multiple DICOM Web servers have been effectively integrated into the University of Washington enterprise-wide web-based EMR, allowing physician access to radiological images using low-cost, ubiquitous web browser technology and wavelet compression.

6. Evaluate the impact of focused integration of data to and among public health practice and clinical practice sites

In Washington State there has long been needed easy and timely access to a variety of public health databases such as death, birth, hospital discharge, cancer registry, and communicable disease data. Public health officers are aware of disease rates at the county level, but not

usually for smaller geographic areas in their county. EpiQMS supports the notion that surveillance, assessment, and interventions are best done in a targeted way by first identifying regions, perhaps down to near street level where problems exist. Access is needed by the public, by local public health departments, and medical practitioners, and by researchers and by investigators dealing with disease outbreaks and cluster investigations as well as for assessment and surveillance support. The data that are available are in the form of accumulated records presenting rates, confidence intervals and statistical measures that allow interpretation of rates for small areas. Event rates are available at the census block group to county level, including Zip Codes, school district, and other geographic scales as appropriate for the database, even user defined. Rates are presented in terms of tables, charts, and maps; all these can be downloaded. Besides age, sex, and race stratified and age adjusted rates, rates are presented which have been adjusted by using empirical Bayesian modeling with rank scores which can be used to determine the likelihood that unstable rates are in fact representing an increase in a disease event in spite of the small population size of the geographic area. Rates are also presented after Monte Carlo simulation using a spatial scan statistic which helps determine where disease rates are elevated, not in just in one particular geographic area such as a single census tract, but in clusters of census tracts.

The security model is based on three levels of access and on the specification that no individual level records are available on the EpiQMS web site. All information is in accumulated form with the individual records having been processed into rates and all the other statistical measures off-line in a separate process not even remotely available to the website. There are three levels of access which determine the level of breakdown the user has with respect to the age by sex by race stratification and to the scale of the geographic area. This is set by assigning different user access levels a dimension access number. This means that lower level access users may be only allowed access to say, Zip Code and county geography only for age by sex or age by race but not age by race by sex. The dimension level of access to different level users is determined by the officer in the health department responsible for the data. The three access levels, public, medical and public health practitioners, and need-to-know investigators are assigned according to standards in policy as set by the WA State Department of Health. They would likely vary with the dataset. For example the public might be able to see the sexually transmitted disease data at the county level stratified by sex, whereas the highest level user would have access to rates at the census block level for age, sex and race, with local medical and public health practitioners having access somewhere in between.

For each dataset, the website has a very large dataset for all possible levels of accumulation, that is disease or condition x age group x sex x race and age adjusted rates for each geography such as block group, census tract, Zip Code, county and possibly school district, legislative district, etc. These databases are typically in the range of millions of records. The access engine is a Microsoft SQL server which is accessed by active server pages (ASP) developed in Microsoft Visual Interdev. Users make queries from drop down menus which are displayed reflecting the access level of the user. The public is the default user, with higher levels having been assigned passwords and user names by the Department of Health. The charts are presented in real time as a client-server application using ChartFX by SoftwareFX Inc. Detailed maps with capacity to add layers, look at event rates near user specified addresses are provided by Maptitude for the Web by Caliper Corporation. Other maps are presented using scalable vector graphics (SVG) allowing especially high quality map images. This particular software combination allows users to have very fast access to the accumulated data and to make almost any combination of tables, charts, and maps.

Before EpiQMS was developed, potential users statewide provided input in a focus group setting concerning what features might be needed. Currently, these same users and others are evaluating the result with feedback concerning the design and performance being made directly to the developers.

7.   Review appropriate evaluation research methods and apply them as appropriate throughout the research projects.   Develop additional evaluation strategies as appropriate

The Institute of Medicine Report on evaluating telecommunications for healthcare was published in 1996. This report provided a valuable starting framework for our work, however we extended the model to include not only the equivalent of the Phase III clinical trial but also, Phase I, II and IV.   Thus our telemedicine evaluation strategy phases include, as appropriate: I. Component(s); II. Tool; III. Product; IV Post Marketing Surveillance.] Central to the success of a telemedicine project and its evaluation is the concept of three essential perspectives of product development representing those who build, use, and sell the product. The evaluation approach proposed for telemedicine projects uses these perspectives in conjunction with a five-stage product development model to select appropriate evaluation methods.   This expanded evaluation model thus accommodates telemedicine projects at a variety of evolutionary stages from very early prototyping through integrated delivery systems.]

Infrastructure components including mechanisms for remote authentication, encryption, secure clinical email, imaging integration and integrated workstations proved the most difficult parts of the evaluation.   In the traditional clinical trial control is vital -- that is, conditions remain unchanged throughout the experiment.   In the UW regional telemedicine testbed the only infrastructure constant was change. Evolving standards for encryption, authentication, imaging and workstations made evaluation of the infrastructure or its components nearly impossible and contributed to difficulties in evaluating other aspects of the project.

The telediagnosis and teleconsultation evaluation benefited from extensive prior experience both in the WWAMI region as well as nationally. Evaluation difficulties encountered include: accruing adequate numbers of similar cases; securing evaluation responses from participating clinicians and patients;   and heterogeneity of consults even within a single specialty. [7] Preliminary analysis of results indicates very high satisfaction among primary care providers, specialists and patients and agreement that televideo consultation can be as effective as an in-person consult.

Evaluating the demand for and use of electronic knowledge resources was accomplished through print and in-person surveys.   Extremely high interest in accessing online library resources was expressed by the majority of participants.   However, in spite of on site training, follow-up surveys found extremely low use.   Masuda et al reports on the details of this study and speculates about potential reasons for this discrepancy. [8]

The final component of the testbed is EpiQMS (Epidemiologic Query and Mapping System) which provides access to data related to health outcomes including morbidity, mortality and hospitalization. EpiQMS has a security access model that allows user access to sensitive data at a variety of levels. Users may query such databases and get disease rates, confidence intervals, and a variety of classical statistical measures in the form of charts, tables, and interactive maps. Evaluation of EpiQMS is in the early prototyping and iterative improvement stages (Phase I as described above).

Conclusion

The WWAMI Regional Telemedicine testbed has provided a very fruitful environment in which to conduct studies on a broad spectrum of telemedicine interventions.   Based on an extension of the IOM telemedicine recommendations a variety of evaluation strategies have been successfully employed to measure technical efficiency, clinical efficacy, satisfaction and utility. Through the evaluation process we have drawn the following general conclusions: 1) there is a regional need for Bench to Bedside (B3) type deliverables   2) the need is less than stated by practitioners as assessed by usage rates and evaluation studies; 3) the reasons for the lower usage/need than stated/anticipated is likely a combination of: recall bias (care providers tend to remember

situations they did not have the needed information out of proportion to the frequency of these event) and barriers to access (limitations in bandwidth and availability of equipment and consults not optimal, the integration of the components of the B3 package not perfect); and 4) in order to deploy tele-resources to small remote practice sites the cost needs to come down (of equipment but more importantly of connectivity/bandwidth) to make the low frequency use of telemedicine at sites like the WWAMI sites cost effective.

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Appendix A

Bench to Bedside Telehealth Site Descriptions

Colville, Washington (NorthEast Washington Medical Group): The NorthEast Washington Medical Group (NEWMG) is a rural multispecialty clinic serving three remote counties (Ferry, Stevens, and Pend Oreille-- known as the Tri-counties) as well as the reservation lands of the Spokane, Colville and Kalispell tribes. This corner of Washington has the lowest per capita income in the state. The local economy is dependent on timber, mining and agriculture, all stagnant industries. However, a large number of retirees have flocked to the area in recent years to take advantage of its natural beauty. The 1995 population for the three counties was estimated to be 53,200.

The Tri-counties are recognized leaders in the Washington health care community for their cooperative health initiatives. The private acute care sector (Mt. Carmel Hospital and the private physicians) works well with the public health departments and there are a number of agencies working hard to improve health for the underserved. The Family Practice residency in Spokane rotates residents through the NEWMG clinic in Colville.

NEWMG has a medical staff of sixteen physicians and six mid-level practitioners, and retention is fairly high. The clinic has approximately 35,000 patient records on file, and clinic providers see approximately 250-300 patients per day.

Isolation issues arise in the outlying places in the counties. Much of the area's 6,082 square miles can be inaccessible in times of bad weather. And even in good weather, professionals in the outlying areas can be isolated by the long travel times over treacherous two-lane roads. By setting up a telemedicine unit in Northport, we intend to address the issues of isolation within the northeast region of Washington

While most of the medical referrals from NEWMG are to Spokane-area hospitals, NEWMG captures a large volume of referrals from Colville's outlying areas.

Petersburg, Alaska (Petersburg Medical Center): Petersburg's population at the 1990 census was 3,500, with another 800-1,000 people in the surrounding villages and camps. The population swells by an additional 500-700 people in the summer; mostly young fishermen, cannery workers, and forestry workers. Petersburg is located in Southeast Alaska (the "panhandle"), approximately 800 miles from Seattle and 800 miles from Anchorage. The town is situated on Mitkof Island (approximately 25 miles by 15 miles) in the center of the Alexander Archipelago. Kake, a native community of 725, lies 40 miles to the southeast. The nearest larger communities are Juneau, Ketchikan and Sitka--each 90 miles away.

There are over 60 miles of improved road on the island, <u>but none lead off the island</u>. The main form of transportation is Alaska Airlines (737) with one flight north and one flight south daily, weather permitting. It takes two stops and four hours to reach Seattle and the tourist round trip fare is approximately $650. The Alaska Ferries stop in Petersburg, almost daily in the summer. It takes approximately 8-10 hours to travel to the larger communities. There are several air taxi operators who can fly to fishing and hunting spots or to the larger communities. It costs approximately $200 per hour to charter a three-passenger plane.

The predominant economic sector is fishing and fish processing. There are four canneries and two cold storages in town. Most of the plants are active only in the summer. Timber is the second sector with several logging camps operating out of the community. Government is the third sector with a U.S. Forest Service Supervisors office and Ranger District Office and a two vessel Coast Guard station.

Petersburg is served by the hospital (12 acute care and 13 long-term care beds) and its clinic. The town has four family physicians. In 1999, there were 51,564 outpatient visits (almost 40,000 of which were labs) and 17 births at the hospital and clinic. Two of the physicians have lived in Petersburg for seven years, but retaining them will be a challenge as the weather and isolation create a setting that poses a hardship for many people. The other two physicians were recruited within the last two years.

Referrals are usually made to Seattle, Juneau, or Anchorage. However, several unique problems also exist in regards to patient transfers and referrals. Isolation is caused by unique geography (an island setting) and dependence on weather when attempting to fly patients out. For example, distance required for minor surgery and OB/GYN is 150 miles--for access to a major referral center, 500 miles. Transfer to the larger communities in Southeast Alaska is usually accomplished with airtaxis. This costs the patient $700-$1000, plus professional time. Space is very cramped for performing procedures and there must be forethought as to where to position patient, nurse and physician. There are similar issues involved with non-emergency transfers. A simple trip to Juneau for a one hour visit will take two days and cost over $350 for airfare, hotel and meals. A trip to Seattle will take a minimum of three days and cost over $1,000

Pomeroy, Washington (**Garfield County Memorial Hospital):** Pomeroy is the county seat of Garfield County, located in the Palouse Hills and Blue Mountain regions in the southeast corner of Washington state. The county's approximately 2,350 residents live within an area of 714 square miles, with 1,465 of those individuals residing in Pomeroy. The area's major industry is agriculture. The Palouse Hills Plateau in the northern part of the county is considered to be one of the most productive wheat-growing regions in the world.

Pomeroy is served by one visiting primary care physician and a nurse practitioner and will be receiving a recently recruited primary care physician beginning in March. The history of recruitment and retention of physicians in this community has not been favorable. In 1999, the hospital had 1,500 outpatient visits. The hospital has 15 acute care beds and 40 devoted to long-term care. 36 of those long term care beds are set up, and currently, 33 are filled. The local public health department provides leadership in health issues from its base at the local school. They, along with the Pomeroy School District, have obtained Birth to Three funding for coordinating services and accessing specialists at the University of Washington for children with special health care needs.

Access to Garfield County is limited by the terrain features. State Route 12 crosses the county from east to west, linking Pomeroy to the Clarkston-Lewiston area 30 minutes to the east where there is a hospital in each town, and the Walla Walla-Tri Cities area (also with a hospital) approximately one-and-a-half hours to the west. Access from the north is provided by State Highway 127 which crosses the Snake river, linking Garfield County to Colfax, Pullman (1 hour 15 min.), and Spokane (2 hours). Garfield County is Washington's smallest and consequently just barely supports its small health care system. Telemedicine has and continues to bring the resources of larger systems (in Seattle or nearby Lewiston, Idaho) to this fragile health care system.

Ronan, Montana (St. Luke Community Hospital): Ronan, Montana, located in the beautiful Mission Valley, lies 60 miles north of Missoula (primary town for referrals) on U. S. Highway 93, arguably the most dangerous, accident-ridden road in Montana. The 20,000 residents of the area include 8,000 members of the Confederated Salish and Kootenai tribes. Most of the land is included in the reservation, but much land is in the hands of the non-Indian population. The area economy is based on agriculture and tourism due to nearby Flathead Lake.

St. Luke Hospital has 24 acute care beds and 75 beds in its long term care section. In 1999 there were a total of 30,962 outpatient visits (386 surgeries, 5,836 emergency visits, 5,528 radiology tests, and 12,670 lab tests) and 94 births. The medical staff is composed of six family physicians,

and orthopedist, and a radiologist. Recruitment and retention are high priorities for the hospital administrator and have been carried out very successfully. Isolation in Ronan is based on the small health system and distance to Missoula, a hazardous trip in good weather and an impossible one during severe winter storms. The local health care system is challenged by serving the needs of the local Native American population, a group with high health care needs and poor coverage for care.

Thermopolis, Wyoming (Hot Springs Memorial Hospital): Thermopolis, Wyoming, a remote town in America's least populous state, is the county seat of Hot Springs County, and home to approximately 3,500 of the County's 4,500 residents. The area features world class trout fishing and hunting. Traditionally, the petroleum industry provided the area's economic base. As that industry has fallen into decline, however, county residents have been employed in a broadening array of industries. This area plays host to tourists on their way to Yellowstone and the Grand Tetons National Parks. 124 miles separates Thermopolis from Casper, Wyoming, location of the nearest interstate highway, I-25. Roads can be difficult to travel in the winter. Salt Lake City, Utah and Denver, Colorado are the nearest major cities and referral areas, at a distance of 375 and 428 miles, respectively.

The local medical community is made up of four family doctors, two surgeons, and a radiologist. Most practitioners have lived and practiced in the area for at least three years. The hospital has 49 beds, and, in 1998 saw 15,718 outpatient visits and 72 births. Thermopolis has had a clinic in Basin, Wyoming (about 60 miles to the north) for about 3 years. A physician staffs the clinic in Basin four half days per week and the rest of the time, the clinic is staffed by a nurse and a clerical person. Telemedicine offers the opportunity to expand the clinic's capacity to manage patients locally by providing constant support for clinic practitioners**.**

Toppenish, Washington (Yakima Valley Farmworkers' Clinic): Yakima Valley Farmworkers' Clinic (YVFWC) primarily provides comprehensive health care services to migrant/seasonal agricultural workers, low-income groups, and enior citizens. The clinic serves a large geographic area and is located in Toppenish, Washington, with satellite clinics in Grandview, Yakima, Walla Walla, Washington and Hermiston, Oregon. At the central clinic, there are five pediatricians, three family physicians, four obstetrician/gynecologists, five internists, four physician assistants, one nurse practitioner, and three dentists. Patient visits per year total approximately 70,000. The clinic's service population is 75% low-income and 80% minority. For specialties not provided at the clinic and for sub-specialty care, patients are referred primarily to Seattle, a two-hour drive across the Cascade mountains. Strong ties already exist between the UW and YVFWC, as evidenced by an extraordinarily high number of calls (approximately 400 per year) to the UW MEDCON telephone consultation service.

Dentistry, rheumatology, and mental health are three are particularly strong areas of linkage. The YVFWC and its affiliated clinics offer primary care, dental, x-ray, pharmacy, and mental health services. Their service population has a number of unique health care needs related to the large number of diabetic patients seen and the absence of adequate dental care (particularly for children), leading to high demand for nutritional and pediatric dental services.

YVFWC's service population faces severe socioeconomic barriers to accessing health care services. Cultural, linguistic, and economic considerations often deter individuals from seeking needed care. Even when these individuals do attempt to access care, they often face long waiting lists. For the majority of these patients, traveling to a major referral center such as Spokane or Seattle to obtain medically indicated specialty care is simply not an option.

Friday Harbor, Washington (InterIsland Medical Center): San Juan County Hospital District No. 1 (InterIsland Medical Center (IIMC)) services a rural area in San Juan County in Washington state. San Juan County is an island archipelago composed of some 172 islands, about 35 of which are inhabited by a population of 12,500. There are three major islands where most of the population is located (Orcas, Lopez, & San Juan), although half of the total population resides on

San Juan Island. Friday Harbor, the county seat, is also on San Juan Island.

Consumers are often unable or unwilling to travel between islands to receive care, due to very limited inter-island ferry service. There are no bridges to the mainland. Only four of the islands are serviced by public ferries to the mainland, and travel time to a medical facility on the mainland may be as much as 10 hours per roundtrip visit. Further, there are no nighttime ferries during nine months of the year and infrequent night runs in the summer. During severe storms, sea and air transportation both become impossible, closing transportation options for up to three days a stretch. Less severe storms are more frequent, and transportation may be unavailable for between 4 and 24 hours due to dense fog or high winds.

IIMC is staffed with 4 full time and 1 part time family practice physicians, 15-20 nurses, and 10-15 other employees. It provides the only family practice and emergency care on the island. The clinic is operated 24/7. There is also an on call physician and nurse providing night and weekend care. Critical emergency and trauma patients are airlifted to the closest hospitals in Anacortes, Bellingham, and Mount Vernon on the mainland. This is a 20-30 minute flight and may be inaccessible during severe weather.

IIMC recorded seeing 22,359 patients in 1999. Nearly all of the 6,000 San Juan Island residents are seen at the clinic, as well as residents from the outer islands. Services cover a broad spectrum from colds to cardiac arrest, and occasionally delivering a baby. The clinic provides general health counseling and often finds physicians counseling for drug, alcohol, and mental health related issues. Laboratory, mammography, ultrasound, X-ray, and minor surgeries and procedures are also services at the clinic.

Driggs, Idaho (Teton Valley Hospital): Driggs is located in Teton County which lies in the southeastern portion of Idaho along the Grand Teton mountain range, approximately 70 miles east of Idaho Falls. Driggs is the county seat with a population of approximately 1,000. It is situated in Idaho's prime potato growing region. Agriculture is the base economy, though recreation and tourism are growing in importance with Grand Targhee Ski Resort as the anchor.

The residents of Driggs are isolated by severe weather during the winter months which limits their ability to traverse a high mountain pass to facilities in Jackson,Wyoming. In the other direction-toward Idaho Falls, they must travel miles of desolate landscape. General/traumatic surgery is referred to St. John's Hospital in Jackson, Wyoming, 45 miles to the east. Cardiac/neurosurgery is referred to Eastern Idaho Regional
Medical Center in Idaho Falls, 70 miles to the west.

Teton Valley Hospital was constructed through a WPA project in 1939, and has been owned and operated by the county ever since.

Medical Services are supplied by three family physicians, two physician assistants, one nurse practitioner, one dentist, and three counselors. Based on data from American Hospital Association Guide to the Health Care Field 1996-97 Edition, the hospital had 13 beds, 302 admissions, 20,095 outpatient visits and 37 births.

University of Washington Physicians Network (Factoria Clinic): One of thirteen clinics in the UW Physicians Network, the UW Physicians Factoria Clinic (located less than 12 miles from Seattle) agreed to be the urban counterpart to this testbed in order to enhance the information we wanted to collect about providing telehealth services to rural AND urban providers. In particular, it served as the test site for Consultations Online, our store-and-forward dermatology demonstration project. This particular clinic provides a full range of health care services, including preventive medicine and treatment for existing problems. The clinic's health care providers include four family practice physicians, three internal medicine physicians, and two physician assistants.

Appendix B
Papers in Progress