Rural Health Care and the Internet:
Issues and Opportunities for Using Interactive Communications to Improve Rural Health Care Services

Dedicated to Andy Nichols, M.D.

By

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Contents

Acknowledgments

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Executive Summary

Health-care and technology experts from government, academia, and the private sector were brought together on July 14, 2000, in Washington, D.C. to discuss the information needs of health-care providers in rural America, to identify barriers to meeting those needs, to identify policies and programs of government and private industry that could help create new opportunities for small, rural, or remote health care facilities and providers, and to make recommendations for a model national program to bring Internet-based applications and technologies to rural America. Participants at the meeting were especially interested in Internet-based networking possibilities among participants in the Area Health Education Centers (AHEC) program, Critical Access Hospitals (CAH), and other health care entities. (Brief descriptions of the AHEC and CAH programs are included in the appendices.)

Since the early 1960s, when telemedicine technologies were first introduced into the health care field, much has been learned about program needs, health applications, equipment requirements, and policy issues related to the use of telemedicine and other information technologies in health care. Traditional hub-and-spoke telemedicine efforts—which were the earliest forms of networks linking specialists located at academic health centers with primary care physicians practicing in remote or rural areas—have evolved into a host of health applications and new technologies which now include Internet-based programs for administration and management, teaching, and training, in addition to patient care support.

Most recently, the explosive growth of the Internet has generated interest among health care providers in learning how the Internet could improve the delivery and quality of health care services in rural areas. Internet technologies offer the promise of a more viable alternative to previously developed telecommunication technologies because of its lower costs, widespread availability, and relative ease of use. By way of comparison, video teleconferencing—which is the technology most often used for patient consultations, teaching and training, and program administration in rural areas—is prohibitively expensive for many rural health care providers, can be difficult to implement and use, and requires dedicated equipment. Many rural health care providers were unable to sustain videoconferencing capabilities when their federal funding expired.

Yet, the promise of using Internet-based technologies remains out of reach for many rural areas because of numerous technical and nontechnical challenges. Reimbursement for clinical services, capital costs of new equipment and high-speed connections (needed to accommodate large data files and images), transmission costs, scarcity of certain technologies in rural areas, and concerns about health information privacy are just a few of the many barriers to rural health care providers and patients going online.

Despite these challenges, many rural health care providers, including AHECs and CAHs, are currently availing themselves of various information technologies. (See appendix C for a listing of information and networking technologies in which some AHECs participate.) Many of these efforts are the result of broad-based cooperation between health institutions, the commercial sector, the local community, states, and the federal government. Some state governments, such as those of Iowa and North Carolina, have led the way in promoting the use of information technology networks for a wide variety of public-sector applications in rural areas, including education and health care. A whole host of federal research-and-development funding is available from a wide range of federal agencies, including the National Library of Medicine, the National Telecommunications and Information Administration, the Office for the Advancement of

Telehealth, and the Rural Utilities Service in the Department of Agriculture. More recently, the commercial sector has begun to provide seed money for developments related to health care and the Internet.

Meeting participants recognized the need to promote national pilot programs that strive toward systematic change, in which processes are reengineered in favor of needs-driven, *sustainable* efforts. The use of appropriate and available technologies, simple solutions, and a high degree of local input and design were also stressed by the meeting participants as key issues in the development of a national model program. Model programs need to be flexible in their approach, scalable to meet the needs of the community, and replicable so that others may learn from and duplicate positive examples demonstrated through model efforts.

As a result of these discussions, meeting participants were able to recommend key elements of a sustainable national program that encourages use of telecommunication technologies to better serve patients, providers, and organizations in rural areas. Specifically, a sustainable national program would take a systems approach to:

- interoperability (ability to exchange information with other systems);
- scalability (elements that work equally well in small or large settings);
- flexibility in approach and in the tools used;
- integration of existing program and technical resources;
- use of low-end and more readily available "off-the-shelf" technologies;
- recognition of the different starting points of most programs;
- adoption of simple solutions and small steps toward improving health services;
- identification and use of "early adopters" among lead clinicians, administrators, and other program advocates within the community, and identification of a passionate "change agent" or champion of the program;
- integral involvement of the community in all aspects of project planning and execution by promoting the concept of "televillage" to help gain support from the public, other health care providers, businesses, and other local constituencies;
- creation of a sense of community awareness and interest in the project;
- involvement of "substate" decision-makers in all aspects of the project, including external advisory and review panels;
- investment in specific desirable outcomes (i.e., cost reduction, improved access, greater efficiency, improved quality) instead of by providers or services**;**
- broad consideration of various technological approaches without bias or preference for any particular technology, and appreciation for the situational and cost needs of host communities and institutions;
- building required state elements for rural development that include state participation from the onset;
- designing systems that are secure and promote patient confidentiality;
- evaluation of program components and technical feasibility that includes "rural-to-rural" as well as "rural-to-urban" outcomes;
- improvement of the quality of information and results;
- consideration of programs that are needs-or demand-driven; and
- basing of projects on an ethical framework toward a greater good.

In addition, the meeting participants reviewed a concept paper, *The Role of Internet*

Technologies in the Delivery of Health Services to Rural Areas—the Arizona Model developed by researchers at the University of Arizona (See Appendix D). The concept paper outlined how a pilot project could be used to investigate the effectiveness of using Internet technologies to support three types of health information services: provider-to-provider, provider-to-patient, and patient-to-patient.

Introduction

An earlier version of this paper, prepared to serve as background for the meeting, has been revised to reflect the discussion and recommendations of the participants. It provides a general overview of issues and policies related to use of the Internet and other sorts of telecommunication technologies to improve access to and quality of health care services in rural parts of the United States. Nontechnical in nature, it seeks to inform health care professionals not especially familiar with telecommunication technologies about some of the issues related to the use of these technologies in the delivery of health care services and to highlight some promising health-related applications.

Telemedicine Comes of Age: A Brief History

To understand the growing uses of the Internet for health care, it is instructive to look briefly at the telemedicine culture and experience. Over the past 40 years the promise of "telemedicine" or "telehealth" has been stated largely in terms of assisting frontier, rural, or other remote communities in the United States and throughout the world. Just as telemedicine has become more widely accepted, telecommunication technologies have changed dramatically, offering small, rural health care organizations a broader array of options by which to incorporate new information technologies into their programs.

Applications of Internet-based technologies to overcome distance barriers that separate providers from patients in rural areas (and from each other) have grown out of a rich history in the telemedicine field. Historically, most traditional telemedicine programs in the United States were designed to help bridge the service gaps resulting from long distances between patient populations and appropriate levels of service. Additional health applications of telemedicine were also developed to help further the education of health care providers and reduce the feeling of isolation rural practitioners often experience.

A 1994 report, *Working Conference on Telemedicine Policy for the National Information Infrastructure (NII)*, concluded that "although telemedicine is not in itself a sufficient incentive to attract and retain providers in underserved areas, it has the potential to enhance recruitment and retention by increasing provider access to information, consultation, and referral. Professional isolation would diminish by virtue of on-going contacts with specialists and the development of integrated networks."[1]

For many reasons, people residing in rural areas—up to 25 percent of the population—may not be able to access the medical technology and specialty care available to their urban or suburban counterparts. "They may have to travel relatively long distances to obtain services, and in any event their options are limited. This problem is most obvious in those areas where transportation is unavailable, infrequently scheduled or prohibitively expensive. In the Western and Great Plains regions of the United States, the nearest tertiary care hospital may be several hundred miles away. Even when medical facilities are less remote, other geographic, economic or cultural factors may severely restrict the availability of health services."[2]

In an effort to address these patient and provider isolation issues, the traditional "hub-and-spoke" telemedicine network grew up around consultations between specialists located at academic medical centers or tertiary care facilities and their primary care colleagues and/or patients located in rural or remote areas.

According to a 1993 report of the Office of Rural Health Policy, *Reaching Rural*, the potential for telecommunications to address many rural health care needs is great. "Applications range from the simple use of the telephone for data transmission to full-motion, two-way interactive video for medical consultation. Rural health practitioners can now conduct consultations in "real time" with specialists in distant medical centers using interactive audiovisual links. This enables rural patients to stay close to home and improves access to specialty care."[3]

Telemedicine is thought to have been implemented first in the late 1950s, when Interactive Televideo (IATV) was used between a psychiatric unit in Omaha, Nebraska, and a rural clinic. In the 1960s, NASA provided satellite support to a telemedicine project conducted by the National Library of Medicine providing health services to Appalachia and the Rocky Mountain region, and also Alaska.[4]

Early telemedicine initiatives also included federally funded demonstration efforts designed to overcome rural isolation such as the Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) project, sponsored by NASA, which helped bring advanced medical technologies and communications to the Papago Indian Reservation in Arizona. The National Science Foundation funded projects that included consultations to jails and nursing home facilities to demonstrate the use of interactive video for examining patients and fax transmissions for consultations between nurse practitioners and physicians.

The very first demonstration projects faced technological, provider-adaptation, and policy barriers that made them difficult to sustain—and although the concept of telemedicine had been proven, almost all were terminated. "At a minimum, these projects demonstrated both the feasibility of and potential benefits to be derived from the use of telecommunications and computer technology in health care delivery. But, equally important questions were left unanswered. In part, this was due to a series of problems faced by early attempts to develop telemedicine." There were severe limitations to available technologies, providers were reluctant to use new technologies in their practice, and the institutions involved were often not committed past the life of the federally funded demonstration project.[5] According to an 1996 Institute of Medicine report, *Telemedicine- A Guide to Assessing Telecommunications in Health Care,* only one telemedicine project started before 1996 survived.[6]

In the early 1990s, technology advances that improved the speed of data transmission and the development of devices that could compress information gave promise to increased uses for rural televideo consultations. Together, these two improvements resulted in higher-quality transmission of data and images at a lower cost. Surveys done by *Telemedicine Today* found that in 1989 there were only 3 active telemedicine programs in North America supporting interactive televideo, but the number grew to 10 by 1993 and 55 by 1996.

The continuing interest in the use of telecommunications for rural health care is demonstrated in a major study conducted for the Office of Rural Health Policy by Abt Associates. With 96 percent of 2,472 nonfederal rural hospitals responding, Abt found that 18 percent reported telemedicine activity in 1995, and concluded that 30 percent would be involved in some form of telemedicine by the end of 1996. The most common applications reported were for radiology and cardiology, followed by orthopedics, dermatology, and psychiatry. The most common nonclinical applications included education, administrative meetings, and system demonstrations.[7] A 1999 report on telemedicine activity sponsored jointly by *Telemedicine Today* and the Association of Telehealth Service Providers (ATSP) identified 179 distinct telemedicine networks (not counting programs run by the Veterans' Administration). Approximately 75,000 teleconsults were estimated to have taken place involving 1,521 facilities and 1,869 rural providers. Nearly two-thirds of active programs in the United States are located within just 15 (mostly rural) states.[8]

For a variety of reasons—including improved practitioner acceptance, advances in technology, existence of standards, and third-party reimbursement—applications of medical imaging (such as teleradiology) have outpaced the use of interactive video consultations in comparison to other kinds of health care services, such as medication management, rehabilitation, and neurology consults. Over time, medical imaging—including the transmission of static images for interpretation—may lend itself more easily to Internet platforms than two-way video consultations because physicians can store and retrieve information as needed when time is not of the essence rather than having to schedule all of the health care providers and the patients to be available at the same time to do a real-time consult in a telemedicine "suite."

For rural providers, critical links to colleagues at major medical centers them achieve a level of professional support and collegiality not previously available, and assist them to remain in communities where they are especially needed. Even so, telemedicine continues to face a series of challenges in the areas of technology and public- and private-sector policy that have limited the incorporation of new telecommunications technologies into the delivery of rural health care. Discussed later in this paper, issues of telecommunications capacity, reimbursement of clinical telemedicine services, cross-state licensure, and practitioner acceptance continue to plague the field.

Emerging Health Uses of the Internet

Telemedicine, Telehealth, and E-Health

Traditional telemedicine technologies (such as real-time interactive video, store-and-forward, and telemonitoring) grew up largely due to interest by health care providers in improving access and the quality of health care services in rural areas. Government, academia, and the commercial sector are now rapidly moving to apply new Internet-based technologies to the delivery of health care in a variety of health care settings and for a much broader range of uses.

The Internet offers consumers and practitioners in rural areas greatly improved access to a world of health information, which, if used appropriately, could lead to a transference of knowledge to support improved decision-making in the areas of consumer health and public health, administration and management, patient care, biomedical research, and health education and professional development.

The Computer Science and Telecommunications Board of the National Research Council discussed emerging health applications in a February 2000 report entitled *Networking Health: Prescriptions for the Internet:*

> Many health-related processes stand to be reshaped by the Internet. In clinical settings, the Internet enables care providers to gain rapid access to information that can aid in the diagnosis of health conditions or the development of suitable treatment plans. It can make patient records, test results, and practice guidelines accessible from the examination room. It can also allow care providers to consult with each other electronically to discuss treatment plans or operative procedures. At the same time, the Internet supports a shift toward more patient-centered care enabling consumers to gather health-related information themselves, to communicate with care providers, health plan administrators, and other consumers electronically, and even to receive care from home. The Internet can also support numerous health-related activities beyond the direct provision of care. By supporting financial and administrative transactions, public health surveillance, professional education, and biomedical research, the Internet can streamline the administrative overhead associated with health care, improve the health of the nation's population, better train health care providers, and lead to new insights into the nature of disease.[9]

If advanced communication technologies were readily available in rural areas, it would be relatively easy to construct Internet-based platforms for rural health care providers so that they could access and exchange a full range of high speed data, graphics, images, and video and voice files for a host of health care uses. But linking health care providers and patients using Web-based technologies will require improved access to technology in many rural areas.

In a November 1999 report *Falling Through the Net: Defining the Digital Divide,* the U.S. Department of Commerce found that "Regardless of income level, Americans living in rural areas are lagging behind in Internet access. Indeed, at the lowest income levels, those in urban areas are more than twice as likely to have Internet access than those earning the same income in rural areas."[10]

A recent Hawaiian study found that although 85 percent of rural health workers had access to computers, only a small minority (30 percent) had modems, and even fewer used online resources or could access the free electronic databases at public and university libraries.[11]

The ability of rural health care organizations to consistently access the Internet begs another important question: Are they able to exchange large amounts of information and data files necessary for most health care applications? Another recent report, *Advanced Telecommunications in Rural America,* by the National Telecommunications and Information Administration (NTIA) and the Rural Utilities Service (RUS) found that rural areas currently lag far behind urban areas in what is known as broadband capabilities.[12]

Broadband (or high-speed) is defined by the NTIA to mean transmission rates significantly higher than the 56 kilobits/second that can be sent through ordinary, high-quality telephone voice circuits. In general, 56 kilobits is likely to be the fastest transmission rate found on many of today's typical computer modems hooked to ordinary phone lines. Even at this "bit rate" capacity, speeds of 56 kb may not be achieved due to overall network considerations, traffic on the Internet, and other factors. The Federal Communications Commission considers that broadband capabilities must be able to support, at a minimum, 200 kilobits/second. The vast majority of our nation's telecommunication infrastructure meets the FCC's criteria, but the problem is in extending that capacity to the user's desk. Because the telephone system—which is how most people connect to the nation's telecommunication infrastructure—was designed to support voice transmissions, not massive data transmissions, the bottleneck generally occurs at the "first mile" and the "last mile" between two points of transmission. Point-to-point or multipoint connectivity is only as fast as the slowest part of any network. In other words, a very high-speed connection has to extend all the way to the health facility, the health provider, the patient's bedside, or the consumer's home to fully realize the benefits of various health applications.

Advanced Telecommunications in Rural America found that only two broadband technologies—cable modem and digital subscriber line (DSL)—are being deployed actively, but most of the expansion is occurring in urban areas. According to an NTIA survey, less than 5 percent of towns with a maximum of 10,000 residents have cable modem service, while more than 65 percent of towns in excess of 250,000 residents have it. Similarly, less than 5 percent of cities up to 10,000 in population have DSL service, while 56 percent of cities with more than 100,000 residents have it. It is fairly clear that these services will not be available to many rural communities in the near future.

Broadband access is important to Internet-based health care applications in rural areas because of the critical nature of the information that needs to be exchanged. Speeds up to 200 kilobits/second are acceptable for lower-resolution, slower-scan conference-quality video (8–12 frames per second) which is usually adequate for many nonclinical sorts of health applications., such as administrative meetings or long-distance education and training sessions. But most clinical, patient-related health care applications require greater speeds to ensure high-quality data transference and a high resolution of images.

Compressing video signals (which is a process of encoding and de-encoding information) allows more data to be transmitted over lower bandwidth lines at a faster speed. Full-motion, compressed video can be achieved at bandwidths of between 128 kilobits/second and 384 kilobits/second. These speeds, acceptable for some clinical applications, are achievable over both cable modems and DSL—*if these services were available in rural areas.*

The Telecommunications Reform Act of 1996, which was the first major overhaul of the nation's telecommunications law in more than 40 years, represented a major move toward additional competition and government-led assistance to achieve better rural connectivity. Yet it will take several more years before it is clear whether programs such as the FCC Universal

Service Fund for schools and libraries and the rural health care program will have their intended effect. (More about the FCC program will be discussed later.)

Is Next Generation Internet the Answer ?

The Next Generation Internet project (NGI), led by the federal government, is leading the way toward expanded Internet capabilities, with the goals of connecting institutions and organizations 100–1,000 times faster than is possible today, promoting new Internet technologies to handle real-time, high-quality video, and demonstrating new applications for critical national priority areas, such as health care. It is hoped that NGI will help deal with some of the major technological barriers for rural areas trying to access the Internet.

The National Library of Medicine (NLM) is spearheading federal efforts on the issue of health uses of the Internet. The agency represents health care interests in the Next Generation Internet initiative, and it also supports major research and development projects using the Internet for health care applications. Part of the NLM's Next Generation Internet commitment includes the convening of major policy meetings to discuss and attempt to resolve technical and policy issues surrounding the use of the Internet for health care services and education.

In 1998 NLM announced a three-phase contract award program to encourage the development of innovative medical projects that demonstrated new applications of Next Generation Internet capabilities in the areas of health care quality, medical data privacy and security, nomadic computing, network management, and infrastructure technology. Phase II local test-bed projects have already been awarded, and while not much of the currently funded research may be immediately applicable to the field, the applied research grants could lead to some useful applications in the near future. (For examples of currently funded NGI projects, see Appendix E.)

Health Applications of Internet-based Technologies

Clinical Programs

From a clinical perspective, it is theoretically possible to provide a wide range of clinical services in an Internet environment. Assuming that many of the technical challenges and legal issues discussed elsewhere can be addressed, it would be highly desirable to move clinical applications to Internet-connected desktops in small rural hospitals, clinics, community health centers, and other practice sites instead of continuing to rely on such prohibitively expensive telemedicine technologies as video teleconferencing or teleradiology which often require dedicated, expensive equipment at both ends. According to an NLM assessment report, "For the most part, remote consultation programs rely on dedicated networks—not the Internet—to provide connectivity between remote clinics and a centralized consulting facility."[13] Eventually, Internet technologies could be used in place of many existing telemedicine technologies—many of which are too expensive for the vast majority of rural health care providers to purchase and maintain—while achieving the same result of improved patient care in rural communities. There are already a number of existing clinical applications of the Internet, including:

- giving emergency room physicians near-real-time access to online medical records to improve patient care;
- providing online telementoring by specialty physicians to primary care doctors performing difficult procedures in remote or rural facilities;
- giving medical students and residents access to online databases at the National Library of Medicine, including MEDLINE, to assist in the bedside care of rural patients;
- providing treatment-plan options to rural clinicians making referral arrangements for specialty care;
- providing evidence-based practice guidelines over the Internet that are linked to online medical records and decision-support tools to help rural clinicians solve difficult cases;
- enhancing communication between physicians and patients about symptoms and treatment options using secure e-mail services;
- providing Internet-based clinician look-up services regarding patient status, transmission of pharmacy orders, patient medical histories, and scheduling of procedures; and
- providing clinical support of postoperative patients in their homes using interactive technologies and telemetry of data.

Teaching and Training Applications

Easy-to-use, interoperable, and reliable equipment is essential to the use of technologies in a distance-education environment. Fortunately, there is a long history of distance-education technologies and applications. Distance-education projects over the Internet make use of a number of Internet technologies, including Web browser access, e-mail, chat rooms, two-way interactive video teleconferencing, video streaming, linear editors, "multicasting" to selected audiences, collaborative white boarding, adjunctive CD-ROM curricula, and voice-over-Internet.

Many medical schools already use distance learning technologies (including the Internet) to extend the reach of their teaching and training programs into medical centers, rural practice sites, and other locations. The American Health Informatics Association has established a

Interactive Learning Campus to meet the needs of members and consultants who cannot travel or rearrange their schedules to obtain training in health care information systems and related topics.

Major trade associations are also educating their members about what the Internet has to offer. The American Group Management Association is conducting continuing education audioconferences for medical practice executives, including core curricula on "Using the Internet to Improve Patient Care and Physician Effectiveness, Practice Operations, Physicians, Patient Relations Areas."

Consumer Health Applications

Many of the more active and robust uses of existing Internet technologies for health care have grown around the movement toward more patient-centered, consumer-enabled care.

> Telecommunications technologies provide consumers with new informational tools to locate and identify information tailored to their particular health status and need. In the past, consumers in need of information turned to their friends or looked for relevant books or pamphlets. Today, the Internet enlarges the range of people and information resources consumers can turn to for information. E-mail, chat rooms, online forums, bulletin boards, and Web pages offer individuals enormous opportunities to access information and share their concerns and inquiries with physicians, nurses, therapists, and with each other.[14]

According to a Harris poll conducted between June 1998 and June 1999, 70 million Americans searched the Web for health information. The Internet Healthcare Coalition cites an excess of 20,000 Web sites devoted to every conceivable health care subject. Some of the most common ailments researched include depression, allergies or sinus problems, cancer, bipolar disorder, arthritis, and high blood pressure. Information on diet and nutrition, women's health issues, and prescription drugs closely follow.

Given the open-ended nature of the World Wide Web and the ease with which organizations and individuals can post information, there is a high degree of concern about the quality of information available on the Internet (a topic discussed in more detail later). Citing a study by the University of Michigan Comprehensive Cancer Center Study, the *Washington Post* reported last August that Web searches can produce a wide variety of results. Researchers found nearly 61,000 sites related to breast cancer, yet little has been done to evaluate Web sites for accuracy. While reliability of health information—in addition to consumer fraud and advertising practices—is a major issue, consumer use of the Internet is predicted to grow beyond merely researching medical conditions.[15] Consumers are also likely to "use the Internet and other networked technologies to conduct health care–related transactions such as scheduling appointments, filling prescriptions, enrolling in health plans, choosing providers, and purchasing health-related products. Some health plans are already providing such access to improve efficiency and service."[16]

Public-Health Population-based Applications

Closely related to consumer health applications of the Internet, public-health proponents have been advocating new uses of the Internet to carry out nonclinical or population-based functions of public health. While the Internet is not specifically mentioned, a seminal 1995 report of the U.S. Public Health Service entitled *Making A Powerful Connection: The Health of the Public and the National Information Infrastructure* concluded that: "The extent to which population-based health can achieve its mission depends, in large part, on the effective collection analysis, use, and communication of health-related information. . . . These data need to be linked to each other and aggregated geographically, so that it is possible to do such things as detect an incipient epidemic from isolated cases seen by different care providers, relate clinical events with proximate health hazards, and correlate the use and costs of personal health care services with ambient behavioral and environmental risks to health."[17]

In its public-health infrastructure goals, the DHHS report *Healthy People 2010* has called for an "increase (in) the proportion of … public health agencies that provide Internet and e-mail access for at least 75 percent of their employees and that teach employees to use the Internet and other electronic information systems to apply data and information to public health practice."[18]

Since 1995, the DHHS Office of Disease Prevention and Health Promotion has led public/private-sector efforts to promote opportunities to use networked communications to advance community and public health programs. The national "Partnership for Networked Consumer Health Information" series, in conjunction with the Annenberg School of Communications, has featured key leaders from public health, health care, and information technology fields, and provided opportunities for learning, networking, and sharing information. Harnessing information technologies for health care was a major theme of their program again this year.

The Centers for Disease Control and Prevention has been in the forefront of efforts to apply new communications technology to public health. The CDC's Public Health Practice Program Office (PHPPO) began an Information Network for Public Health Officials (INPHO) in 1993 that has helped stimulate 19 states to develop Internet connectivity for public health professionals, to design and implement applications and data tools responsive to their specific needs, and to improve the exchange and use of data.[19]

A joint NLM, CDC, HRSA and private-sector project called "Partners in Information Access" has awarded 20 grants to help public health officials hook up to the Internet to gain access to health information. Other examples of government-led Internet applications for public health include various information resources of DHHS agencies, such as the Health Finder Web site of the Office of Disease Prevention and Health Promotion, and the databases of the National Library of Medicine including AIDSLINE, TOXNET, and ChemID.

At the state level, the Ohio NetWellness program—which started as an 1994 community-wide consumer health information effort of the University of Cincinnati with funding from the U.S. Department of Commerce's National Technology and Information Assistance Program (TIIAP)—has grown into a major state-supported online public health effort. Using the Ohio Public Library Information Network (OPLIN), NetWellness provides high-speed access to consumer information and patient education resources at 700 libraries involving more than 6,000 computers statewide.

Commercial-Sector Initiatives

Many major health care and technology companies have established an Internet presence both to stake out territory for their goods and services and to begin exploring the value to be gained from migrating clinical care, consumer, and patient management, and other services to the World Wide Web.

Commercial enterprises have viewed the explosive growth in telecommunications and computers, increased demand for health information and shared decision-making, increased emphasis on prevention, and trends toward reducing the costs of health care while improving efficiency as major opportunities to introduce new information technologies for health care services.

In a recent white paper entitled *Why Intel Is Involved in Health: The Internet as a Driving Force of Societal Change,* the chipmaker concludes; "Quite simply, Intel is interested in helping consumers to find new ways to use personal computers, and increasing the number of people who purchase a PC to help manage their health. Today, personal computers are used for a huge array of applications: word processing, accounting, games, networking, email and the Internet; they are hardly used for health. The winds of change are looming: demanding consumers, the Internet, and an ailing health system are driving this revolution."[20]

In May 1999, Healtheon/WebMD released its *Internet Survey of Medicine,* which showed that 85 percent of physicians surveyed were currently using the Internet, a jump of 875 percent since 1997. In that same month, Jupiter Communications issued a research report which projected that despite regulatory hurdles, limited product offerings, and distribution complexities, the online consumer healthcare market is expected to grow to $1.7 billion by 2003.[21]

As of January 31, 2000, a research report by Wit Capital Group entitled *eHealth 2000: Healthcare and the Internet in the New Millennium* found that for 1999 and 2000 alone, there were 25 e-health IPOs with an initial $1.8 billion in capital raised. These include Healtheon, drkoop.com, Allscripts, PlanetRx.com, Medicalogic, and HealthStream. New business-to-business Internet organizations are starting to approach applications beyond the traditional consumer search functions of the Web including disease and health management, drug discovery, drug development, wireless and mobile computing, defined contribution, and telemedicine.[22]

America'sDoctor gives patients live Internet connectivity for consultations with on-call physicians. Cybear, Inc., provides Internet portal and application service provider (ASP) services to medical practices for laboratory order entry, lab results, management functions, and professional e-commerce. (Health care organizations interested in reducing their in-house technology commitments can make use of ASPs, which operate large data centers and client/server networks so that organizations can obtain their information from linked computer terminals.) Caredata.com offers Web-based streamlined credentialing services, and Esurg.com is promoting surgical supply ordering on the Internet. Phase Forward, Inc., and Fast Track, Inc., are providing the software technologies and services needed to conduct clinical trials on the Internet as a way to help pharmaceutical companies bring new drugs to market faster. Florida-based Cyber-Care, Inc., has been developing and deploying Electronic HouseCall, an Internet-based videoconferencing system that allows providers to monitor patients remotely in their homes. Medicalogic Inc., which recently merged with health professional content provider Medscape, is establishing portal services for providers to keep and access electronic medical records online. The Fox Entertainment Group, Inc., has launched the Health Network a combined Web site and cable television network offering consumer health information, including online prescription ordering through PlanetRx.com.

Policy Issues at a State, Federal, and Private-Sector Level

There have been a variety of studies and reports identifying policy issues related to the use of telecommunications in health care. The 1993 Airlie House *Working Conference on Telemedicine Policy For the NII* identified a series of regulatory, technical, and human infrastructure issues and policy recommendations that needed to be addressed to assist in the design, development, implementation, and evaluation of health-oriented applications of telecommunications.[23]

A 1996 report by the Center for Public Service Communications entitled *Issues and Barriers Facing Health Oriented Applications of Telecommunications* found well over 50 distinct public- and private-sector policy issues confronting the field. More than 20 major policy studies done during the mid-to-late 1990s have identified a similar range of policy issues that include: telehealth cost and payment issues, licensure and accreditation, acceptance on the part of providers, privacy and security of information transmitted, technical standards, and research-related matters. While some of the original telehealth issues have been at least partially resolved, many remain, and when added to a new set of Internet-specific policy issues, the result is a new, expanded agenda for the field.

Reimbursement and Up-front Capital Costs

Following years of effort on the part of a largely rural telehealth constituency, legislation was enacted during consideration of the Balanced Budget Act of 1997 that required Medicare to provide limited reimbursement for real-time clinical consultations. Since then, intensive efforts have been underway to expand the scope and coverage of Medicare's payment policies to include a fuller range of reimbursable services in rural areas that involves a wider spectrum of technologies.

While federal Medicaid law does not recognize telemedicine as a distinct service, at least 18 states, at their option, have adopted fee-for-service payment policies. The following states have (or are developing) telemedicine reimbursement policies for their Medicaid programs: Arkansas, California, Georgia, Iowa, Illinois, Kansas, Louisiana, Maine, Montana, Nebraska, North Carolina, North Dakota, Oklahoma, South Dakota, Texas, Utah, Virginia, and West Virginia.

In addition, at least four states including California, Louisiana, Oklahoma, and Texas, have enacted laws prohibiting discrimination against telehealth in private indemnity plans. Commercial insurers, for the most part, have adopted a range of payment policies with regard to telehealth reimbursement.

For Internet applications, the issue of reimbursement is made more complicated by issues regarding the quality and veracity of information being provided. Settling the reimbursement issue matters because of the program costs (personnel, equipment, and high-bandwidth-transmission costs) involved with using advanced telecommunications for health care.

"Government program reimbursement for IHC (Interactive Health Communication)-mediated services seems to be relatively low on the priority list. Private health plans and insurers also may not be proactive in this area but they may be more likely to initiate reimbursement of specific IHC applications if they are proven to be cost-effective."[24] On May 1, 2000, First Health Group Corporation of Downers Grove, Illinois, announced what is believed to be the first instance of a managed care organization reimbursing for Internet consultations. The plan said it would pay $25 for "clinical content" sent via electronic mail between physicians and patients.[25]

A closely related issue to reimbursement is the up-front investment needed to fund an

Internet project**.** Private-sector investment is derived from investment capital, while the federal government's funding role has generally been through agency grants, contracts, and other assistance programs; intramurally funded research-and-development efforts at organizations such as the Department of Defense or NASA; and tax policy.

Creation of the Federal Communication Commission's Rural Health Care Program under the Telecommunications Act of 1996 established a mechanism for distributing up to $400 million per year from a special fund to benefit rural health care telecommunications by subsidizing high-speed connectivity. In general, rural areas are subject to significantly higher charges for telecommunication services than urban areas. Under this program, rural health care providers can apply for discounted telecommunication rates to help them afford high-speed transmission costs.

Telecommunication services have been estimated to constitute about 18 percent of a rural provider's overall telemedicine costs, and while the FCC's Rural Health Care program has faced major administrative stumbling blocks, there is hope that it will eventually benefit large numbers of rural programs. In 2000, 410 rural health care organizations received more than $6 million in support. While the FCC program includes limited support for Internet connections, many rural advocates have promoted expanding the effort to include the costs of additional telecommunications services, computers, and other needed equipment.

Technology-related Issues

Telemedicine, and now "e-health," face a series of technical challenges. As was previously discussed, limitations of bandwidth for high-end health care applications—particularly in rural areas—must be resolved.

In addition, there are a host of software, hardware, and network issues. Critical, for example, is "interoperability," or the ability for otherwise-disparate systems to exchange information with each other. Another related issue is "scalability." Systems that scale have components that work equally well in small or large settings.

Many of the clinical software health care programs currently available do not integrate readily with each other or with Internet-based conferencing capabilities. Therefore, it is difficult for health care providers to discuss patient care online because the patient data software is not necessarily compatible and easily shared during online communication. It is easy to image the benefits of being able to hold grand rounds between rural health care providers and specialists at an academic health centers while being able to instantly view important clinical information, such as a patient's MRI, or a patient's physical symptoms, such as skin lesions, while discussing that patient's care.

In an Internet environment, achieving "quality of service, or QOS, is critically important. Technical QOS has to do with an assurance that information can be delivered quickly and accurately through a complex network of Internet service providers, routers, and switches. Given the different levels of available Internet service (depending on location, equipment used, etc.) health care users must be assured that the information needed to make critical medical determinations is consistently and reliably available. For example, a health care provider must be able to depend on being able to quickly retrieve and review a patient's electronic medical record when that person shows up in the emergency room. Both bandwidth and latency (time delays) come into play. For health care, lost or delayed information is not a mere inconvenience but potentially life threatening. With regard to QOS, industry and government are being encouraged to develop policies and protocols that guarantee improvements across the Internet.[26]

Human-Dimension Issues

For many years, policy analysts, program specialists, and administrators have understood that a series of interpersonal or "human-dimension" issues face the implementation of new communications technologies for healthcare. *Reaching Rural*, the 1993 report at the Office of Rural Health Policy (ORHP), concluded that patient and provider acceptance of technologies was critical.[27] The Airlie House Conference and report called for consideration of human needs and preferences in recommending "client-centered systems which assure autonomy and the right of individuals to make informed decisions [and] consideration of issues such as community needs, preferences and available resources"[28]

A study by the California Health Care Foundation found that "physicians are both threatened and fascinated by the Web. Many understand the value of having well-informed patients and the role the Internet can play in educating patients. At the same time, they are concerned about losing control over the interaction with their patients."[29]

The Human Dimension of Telemedicine: Barriers to Practitioner Acceptance, a 1995 workshop and report by the Center for Public Service Communications (CPSC) on behalf of ORHP focused on the identification of factors that influence the adaptation to and adoption of telemedicine technologies to enhance practice or improve patient access in rural areas. Important human-dimension concerns and barriers to practitioner acceptance included: lack of reimbursement and financing; lack of proof of benefit to the practitioner; concerns about ease with which technology can be incorporated into existing practice patterns; problems related to equipment; inadequate needs assessments; lack of "critical mass" of experience and information; lack of active involvement of clinicians; changing referral patterns; concerns about liability; concerns about control, professional image, and pride issues; societal readiness for new technologies in health care; and sustainability of projects.[30]

Privacy and Security of Medical Information

New uses of information technology for health care, while exciting, have also caused concern that threats and vulnerabilities exist with regard to data security, data integrity, and the ultimate privacy of patients.

> Unless proper controls are in place, computer systems and networks can be accessed by unauthorized users. If not adequately addressed, such concerns can both dissuade health care organizations from investing in information technology and make patients reluctant to share information, undermining the provision of care.[31]

There are good business reasons why organizations will want to take steps to protect their data. The development of online personal medical records by Dr.Koop.com, Healtheon/WebMD, and Medicalogic, Inc., makes imperative the protection of highly sensitive information. Respondents to a Healtheon survey of potential physician Internet users last year found that 34 percent noted that security remains a primary concern in the use of e-mail or other interactive services.[32]

In any case, the federal government is now poised to act. The Health Insurance Portability and Accountability Act of 1996 (HIPAA) set out a series of changes to the legal and regulatory environment for medical records, requiring (among other things) the federal Department of Health and Human Services to adopt new administrative simplification regulations relating to data security, electronic signatures, and privacy of health information.

Nine major sets of standards are in various stages of promulgation, including several hundred pages dealing with new security and privacy requirements of the nation's 500,000 health plans, providers, and clearinghouses. Most major health care organizations will have two years to comply, while smaller rural hospitals will be given three years once the regulations are finalized. It is expected that many of the key regulations on data security and health information privacy will be finalized by the end of 2000.

For networked systems the implications of new HIPAA requirements are unclear. For example, Internet and telehealth programs will first need to determine what information is covered under the rules. DHHS, for instance, has concluded that information which is "electronically transmitted" or "electronically maintained" is covered. "Protected information would result from any computer or electronic media generation, storage or transmission even if it is later physically moved between locations or converted into paper format."[33] In addition, data capture and storage devices, including computer hard drives, magnetic disks, optical storage devices, and front-end diagnostic equipment such as radiologic imaging and ultrasound, will also have to be compliant with new technical and other security measures called for under HIPAA.

Finally, proprietary and open networks including Intranets (an Internet-like system that is closed and available only to individuals of a particular organization), Extranets (similar to an Intranet system but open to a select audience, such as a hospital's medical supplier or an individual physician's office), and transmissions over the Internet will have to be secured. Health care organizations will have to guarantee a chain of trust to ensure that protected information remains protected as it is shared among colleagues, business partners, and facilities. In the final analysis, rural health care organizations (including critical access hospitals and Area Health Education Centers) will have to adopt a series of new policies and procedures to guard the integrity and confidentiality of their health information—whether or not they become involved in new Internet applications and technologies.

Medical-Legal Issues

Health care providers need to be aware of a range of existing and emerging medical-legal issues facing the Internet health field. Licensure, medical malpractice, and accreditation matters have been framed fairly well from a public policy perspective because of previous experiences with telehealth technologies. Clinical Internet applications face a major obstacle related to our nation's state-based licensure system, which requires that physicians and other providers obtain individual licenses for each state in which they practice medicine. "As telemedicine consultations begin to cross state lines, states have been confronted with the problem of 'where' the consultation is actually occurring. The underlying question is whether the patient or the physician travels over the telecommunications network during a telemedicine consultation."[34]

State medical examining boards have addressed the issue in a number of ways. In some states (Colorado and Kansas), provisions have been enacted clearly requiring that a physician who treats, prescribes, or practices in the state must first obtain an in-state license. Other states (Arkansas and Tennessee) have sought to accommodate telemedicine by allowing occasional or requested services by out-of-state physicians provided they do not establish offices in the host jurisdiction. To date, 20 states have enacted changes in their licensure laws or regulations in response to telemedicine technologies.

Fortunately, efforts are underway—in part led by the Federation of State Medical

Boards—to implement a model act for the practice of medicine across state lines. The National Council of State Boards of Nursing (NCSBN) is taking a slightly different tackt. NCSBN has been working to promote an interstate mutual-recognition pact. Nursing licenses would continue to be issued by individual states but would be recognized by other states, just as driver's licenses are now.

Yet another emerging legal issue for Internet health applications is the potential for medical malpractice and liability on the part of practitioners and organizations sponsoring content. "Assuming the procedural issue of jurisdiction over a telemedicine procedure can be determined, is a physician liable for malpractice for transmitting or receiving an inaccurate telemedical opinion ?"[35]

In addition to worries over individual liability, health care and technology organizations need to be concerned about their exposure. "Providing medical advice through Interactive Health Communications (IHC) applications, including Web sites, increase potential liability for developers. This may be especially true for more sophisticated applications that provide decision support in high-consequence areas."[36] In general, liability concerns are growing because of the largely unchecked nature of information provided on the Web. In many cases, the sources cannot be adequately identified nor can their credentials be verified.

Some of these major policy issues may have more connection with one other than was previously thought. For example, technology policy leaders are now asserting an interrelationship between the e-health issues of privacy, quality of information, and tort liability.

In the *Journal of the American Medical Association,* Hodge, Gostin, and Jacobsen assert in their article *"Legal Issues Concerning Electronic Heath Information"* that "protecting health information privacy (by providing individuals some control concerning their health data without severely restricting warranted use of the data) directly improves the quality and reliability of health data (by encouraging individuals to fully use health services and allowing communal uses of the data for societal goods), which diminishes tort-based liabilities (by reducing the opportunities for medical malpractice or invasions of individual privacy, improving the quality and reliability of health research data, and ultimately improving the quality of clinical care and medical products in the marketplace)."[37]

Preferring to self-regulate if at all possible, the Internet health industry is attempting to act on its own. The Hi-Ethics group has been formed by a number of companies, including America Online, AmericasDoctor.com, drKoop.com, InteliHealth, Medscape, PlanetRx, and others to "establish and comply with the highest standards for privacy, security, credibility and reliability so that consumers can realize the fullest benefits of the Internet."[38]

In addition, the Internet Healthcare Coalition (IHC) has been established by industry leaders to "promote ethical principles relevant to the fast expanding area of online, interactive healthcare communications, through the consensus of industry, academic, government, patients, and consumer leaders."[39] In May 2000 the Internet Healthcare Coalition issued the *e-Health Code of Ethics* that touched on issues of: candor, honesty, quality, informed consent, privacy, online professionalism, responsible partnering, and accountability. IHC also sponsors a yearly e-Health Ethics Summit. Additional private-sector responses to growing regulatory concerns include those major national trade groups such as the American Medical Association, which passed a resolution in May 2000 to "support a universal code of ethics for Internet health sites . . . [and] assume a leadership role in structuring this code of ethics in the context of the e-Health Ethics Summit."[40]

Worldwide, the Swiss-based nonprofit Health on the Net Foundation (HON) has emerged as one of the leading private-sector organizations implementing a code of conduct for health care sites. HON also sponsors research and conferences regarding its primary concern: quality of health information on the net.

Funding Opportunities

Most telehealth projects in the United States were funded with at least some federal government participation and support. Interestingly, most emerging health applications of the Internet are now being conducted and capitalized in the commercial sector. Only recently have government programs started turning their attention from two-way interactive clinical video consultations to some of the Internet technologies and applications described in this paper.

Telemedicine: Federal Strategy is Needed to Guide Investments, a 1997 report by the General Accounting Office to Congressional requesters, concluded that nine federal departments and agencies had invested at least $646 million in telemedicine projects between fiscal years 1994 and 1996. The largest single federal investor was the Department of Defense at $262 million, followed by the Veterans Health Administration at $142 million, the Department of Health and Human Services at $110 million, and the Department of Commerce at $106 million.[41]

By contrast, it has been projected that the Internet consumer health market will be a $1.7 billion business by 2003. The market capitalization of Internet health care companies has already grown into the billions—mostly without any government involvement. See Appendix F for a review of federal funding efforts in the area of telemedicine, telehealth, and Internet applications for healthcare, as well as information on some potential private-sector sources of funding.

Appendix A
Area Health Education Centers

The Area Health Education Center (AHEC) program was established in the early 1970s as a way to encourage health care professionals to practice in underserved areas by exposing them to a clinical health care experience in an underserved setting during their training period. There had been evidence that individuals who have participated in the delivery of health care services in an underserved area are more likely to enter practice in an underserved area. There are currently 40 AHEC programs with 170 centers across the country.[42]

In 1996 Dr. Wayne Myers (now director of the federal Office of Rural Health Policy) testified on behalf of the Rural Policy Research Institute (RUPRI), on Rural Health Workforce Policy Issues before the House Ways and Means Subcommittee on Health. In his testimony, Dr. Myers acknowledged that the AHEC programs "enrich the practice environment" in underserved communities and "give health professions students a better understanding of rural practices." But he also testified that the AHEC program "has not been shown to influence student career decisions."[43]

While it had always been part of AHEC's mission to provide training opportunities in underserved areas to individuals from minority or disadvantaged backgrounds, the Bureau of Health Professions, beginning in the mid-1990s, began more emphatically to encourage AHEC programs to focus on this. These characteristics are even more strongly correlated with returning to practice in an underserved area than merely being exposed to practice in an underserved area. As part of this effort, significant progress has been made in exposing minority/disadvantaged students to health care profession options while in high school, and even elementary school. Almost 6,000 teachers and counselors have been trained in "Health Careers" in more than 3,000 high schools, 63 percent of which were located in underserved areas.[44]

Currently, 76 percent of AHEC programs are providing health care enrichment programming to high school students. Last year, almost 25,000 high school students participated in at least 20 hours of programming. Thirty five percent of the AHEC programs that were able to track student participants in a health care enrichment program found that 251 enrolled in a health professions training program and more than 671 enrolled in prehealth-career college programs.[45]

Besides exposing health care professionals-in-training to practice in underserved communities, this program allows residents of these communities to gain access to basic health care services that would otherwise be unavailable. One measure of the program's success used by the Bureau of Health Professions is the number of training slots funded on an annual basis. In 1998, 25,000 health care professionals, including nurses, dentists, and physicians had a training experience in an underserved area.[46] That number grew to 27,000 in 1999 and was projected to reach 30,000 in 2000.[47]

More than 77 percent (112 out of 144) of all medical schools currently participate in the AHEC program. Besides providing training opportunities to undergraduate medical students and primary care residents, the AHEC programs provide training opportunities to students in a wide variety of health-related disciplines, including nursing, dentistry, mental health, pharmacy, and allied health personnel. More than 500 community health and migrant health centers serve as training sites.[48]

A number of AHEC programs have already become quite heavily involved in the use of new technologies for training purposes, distance learning, and patient care. For example, East Carolina University was designated a key resource for other AHEC sites in the development of

Web sites. As a result, almost 50 percent of all AHECs now have their own Web sites. And this year, for the first time, AHEC programs must provide performance information to the Bureau of Health Professions on the number of continuing education programs provided through distance learning technology.

Appendix B
Critical Access Hospitals

In the Balanced Budget Act of 1997, a new, national, limited-service hospital program was enacted into law, modeled on the success of two similar but slightly different experimental limited-service programs already operating in the state of Montana: Montana Medical Assistance Facilities (MAFs) and EACH/RPCH, a program also operating in seven other states. The Critical Access Hospital (CAH) program was, for the most part, developed by adopting the most promising and desirable aspects of the MAF and EACH/RPCH programs.

Under the new limited-service model, acute care hospitals that can no longer sustain a full level of services in their local communities but are nonetheless vital to assuring access to basic health and emergency care services would be allowed to downsize their service mix to better fit the needs of their communities. Critical Access Hospitals must be located in a rural area, provide 24-hour emergency care, limit hospital stays to an average of 4 days, and limit the overall number of inpatient beds to 15.[49] As of May 19, 2000, 170 hospitals have been designated critical access hospitals.[50]

Because of the relative newness of a national limited-service hospital program, the additional legislative clarifications to the CAH program that were included in the Balanced Budget Refinement Act of 1999, and delayed grant funding for the "Rural Hospital Flexibility" program that was included in the original authorizing legislation, experiences, so far, are limited and still very much a work-in-progress. The Rural Hospital Flexibility program provides funding to States to help with designating rural hospitals as CAHs and for the development of networks to improve access to care.

To date, most network development between a rural limited-service hospital and another, usually larger, acute-care hospital has focused on important but not technologically elaborate relationships related to patient referrals, communications, and transportation. Those are the relationships that are currently required by law between a CAH and an acute-care hospital, although, some CAHs are moving beyond this sort of basic network relationship. For example, in Oklahoma a CAH has a teleradiolgy consulting arrangement with an acute-care hospital that allows for almost real-time reading of a patient's CT scan. This is especially important in instances of stroke to make sure that the patient receives the appropriate medicine as quickly as possible.[51]

The Office of Rural Health Policy already has set in motion an ambitious tracking/evaluation system so that information on this new program will be available in the not-too-distant future.

Appendix C
Information Technologies and Area Health Education Centers (AHECs)

- **Brief Descriptions of Telehealth-focused Projects**

  - **Montana Healthcare Telecommunications Alliance**
    The Montana Healthcare Telecommunications Alliance was formed by a number of institutions and organizations in 1997 under the leadership of the AHEC at the University of Montana to promote advancements in telecommunications through video teleconferencing and telemedicine.

  - **Southwest Louisiana Hospital**
    The Telehealth Network of Louisiana involves a consortium of hospitals, universities, and state facilities (including the Southwest Louisiana AHEC) that will provide rural access to a number of basic and specialized medical services, including preventive care, patient education services, continuing education for health care professionals, and wellness education for the general public. The program, funded by the Department of Commerce's Technology Opportunities Program, will primarily use video teleconferencing technology.

  - **University of Arkansas for Medical Sciences (UAMS)**
    The UAMS Interactive Video Network uses interactive videoconferencing to connect 36 sites, including 18 rural hospitals, 8 AHECs, 3 community health centers, 1 rural health clinic, several sites across the campus, and the University Hospital. The system is used for clinical and educational programs, including continuing education for health professionals, training of nursing and allied health students, statewide professional meetings, administrative meetings, and consumer health education programs.

  - **University of Florida College of Medicine**
    The Office of Medical Informatics at the University of Florida's College of Medicine is working with North Florida AHECs (Suwanne River AHEC, Big Bend AHEC, Northeast Florida AHEC, and West Florida AHEC) and the Gainesville VA Medical Center Geriatric Research Center to provide continuing medical education on the health management of older adults using audiocassette tapes. The University's Medical Education Server is used extensively to provide medical-school and continuing-education course information with links to AHEC-led Web site providing information on health careers.

  - **University of Vermont**
    The Vermont Rural Telehealth Initiative, funded by the federal HRSA Office for the Advancement of Telehealth, supports video conferencing over high-speed ISDN lines to connect 19 sites in Vermont and upstate New York, including 3 AHEC sites. Centered at the Fletcher Allen Health Center in Vermont**,** the network is focused on clinical services, such as patient consultations and patient education.

  - **Utah Telemedicine Network**
    The Telemedicine Outreach Program at the University of Utah is supported by three

different federal grants and comprises nine hospitals, including the Utah AHEC. This program provides video teleconferencing for continuing medical education and information technology training, along with teleradiology, medical consultations, and access to medical databases.

♦ **Brief Description of Telehealth and Internet-based Projects**

- **East Carolina University**
  North Carolina has led the nation in telehealth-related activities, encouraged by a 1994 Executive Order establishing the statewide North Carolina Healthcare Information and Communications Alliance, Inc. The Eastern North Carolina AHEC and East Carolina University in Greenville are teaming up with two school systems to improve access to health resources for students. East Carolina uses a combination of technologies, including videoconferencing, fax, and the Internet, to deliver health education classes, clinical consultations, and workshops for program participants. Extensive information on health occupations, educational requirements, and practice location information is available.

  In 2000 the consortium was awarded a $4.5 million contract by the National Library of Medicine (NLM) to develop more effective approaches to health applications on the Internet under the NLM's Next Generation Internet project. Among other things, ECU is working closely with the Eastern North Carolina AHEC to build and evaluate networks that allow transmission of clinical quality audio and back-end databases of pediatric heart sounds,and that can be used as a teaching tool for medical students and residents.

- **East Texas Area Health Education Center**
  Under a grant from the Department of Commerce's Technology Opportunities Program, the East Texas AHEC, the Division of Pediatric Special Services at the University of Texas, and the Department of Nursing at Lamar University in Beaumont are using a combination of videoconferencing and Internet connectivity to address specia- needs children, as well as expose faculty and students in the health professions to technology and experiences in caring for, and training others to care for, special-needs children. In addition, the HRSA Office for the Advancement of Telehealth and the federal AHEC Office are jointly funding support for a nurse to provide telehealth triage activities.

- **Nevada Rural Hospital Project Foundation**
  The Nevada Rural Hospital Project Foundation, which includes participation of the Nevada AHEC and the Nevada School of Medicine, is establishing a telehealth video, voice, and data network to connect four rural hospitals. The project will provide clinical support to rural practitioners to assist them in upgrading their skills, and will conducting research with the goal of retaining both patients and providers in their local communities.

- **University of Arizona**
  The University of Arizona is home to the Arizona Rural Telemedicine Network (ARTN), administered through the Arizona Telemedicine Program (ATP). The network integrates multiple programs covering medical care, education and training, and research and demonstration in technology utilization. Funding for the ARTN has been made possible

through an annual appropriation from the Arizona state legislature, the Office for the Advancement of Telehealth, the Rural Utilities Services, and the National Technology Opportunities Program. The ATP operates a 12-site telemedicine network. The program has conducted more than 6,000 clinical, administrative, and educational sessions since July 1997. The telemedicine network is based on Internet technology protected by a firewall. Rural sites can access Internet-based resources as well as clinical specialty services.

In 1997 the Rural Health Office (RHO) received a grant from the Department of Commerce to plan for the integration of videoconferencing services and Internet access for three "enterprise communities" at the U.S.-Mexican border as part of the state-funded Arizona Telemedicine Network. The grant also resulted in a survey of rural physicians to assess their interest in collaborating in telemedicine technology.

The Rural Health Office is also based at the University of Arizona. RHO staff members have been integrally involved with the evolution of the Arizona Telemedicine Network since its inception, as well as the new federally sponsored Critical Access Hospital (CAH) program. The Arizona CAH program is in the process of implementing a demonstration program involving PC-based videoconferencing technology, which will connect the state's CAH hospitals for education and training sessions and for administrative communications. Phase I of the demonstration connects the RHO to three divisions (Emergency Services, Licensure, and Planning) within the Arizona Department of Health Services, which are involved in the implementation of the CAH program.

- **University of Cincinnati College of Nursing and Health**
  The University of Cincinnati College of Nursing, along with Cincinnati Bell, Adams County Hospital, Clermont County Extension, and its AHEC, is using a Department of Commerce grant to provide RNs access to undergraduate and graduate nursing education in rural and medically underserved areas. Technologies will include community interactive video sites linked to the statewide fiber network OhioLINK, the Internet, and the University of Cincinnati network. Students will be able to access networks from a variety of locations to take courses and to communicate with faculty and other students.

- **University of Missouri**
  The Missouri Telemedicine Network—under a grant from the federal Office for the Advancement of Telehealth—is using a combination of interactive videoconferencing and a PC-based network to connect 21 sites that include hospitals, primary care clinics, two medical schools, and two AHECs. Among other things, the network is being used to supplement the supervision of rural AHEC medical students and residents.

- **University of North Carolina at Chapel Hill**
  The North Carolina Rural Telemedicine System (NC-RTS) involves several university and rural-based facilities focusing on interactive videoconferencing for geriatric care. One of the NC-RTS partners is the Area L AHEC, which is working to further develop programs for interdisciplinary training.

- **University of Texas Health Sciences Center at San Antonio**
  Begun in 1995 with funding from NASA and private corporations, the UTHSCSA

telemedicine program is now well established. Covering more than 53,000 square miles throughout southern Texas, it includes 40 hospitals and clinics, including Laredo and Weslaco AHECs. UTHSCSA transmits more than 150 hours per week of distance learning programs, and while most are via videoconferencing, increasingly newer desktop systems are giving rise to e-mail and Internet capabilities.

- **Western AHEC Regional Distance Learning System (WARDLS)**
  AHECs in 15 states are working to establish a distance education program for health professionals, to be delivered through the recently announced Western Governors' University (WGU). Western Governors' University was formed to expand postsecondary-education opportunities for Western residents, demonstrate new approaches to teaching, and provide alternate locales for students to obtain continuing education. The AHECs and the WGU propose to assess health professionals' needs with regard to distance education, identify existing distance education courses, determine project partners, identify potential funding sources, and formulate a strategic plan to offer distance education programs to health professionals.

- **Western North Carolina Rural Primary Support Network**
  The Western North Carolina Rural Primary Support Network, serving a 16-county rural, southern Appalachian region that includes the Mountain AHEC, provides rural primary-care support, help in recruiting new physicians and supporting existing ones; and technical support to local communities. Using both Internet access and videoconferencing, the project includes a rural fellowship program to orient and prepare prospective rural physicians, and a *locus tenens* program that gives rural physicians time away for continuing education. The AHEC also offers basic and advanced training in selected computer applications, including the use of the Internet and its databases.

Appendix D
The Role of Internet Technologies in the Delivery of Health Services to Rural Areas: The Arizona Model

KM. McNeill Ph.D., A. Nichols M.D. & A. Hughes M.P.A.

Abstract
This model defines the Arizona concept of how a pilot project can be used to investigate the efficacy of using Internet technologies to support three types of Health Information services: Provider-to-Provider Information Services; Provider-to-Patient Information Services and Patient-to-Patient Information Services. Provider-to-Provider services will support secure interaction between providers to enable them to consult regarding the healthcare of specific individuals. Provider-to-Patient services will support secure interaction between providers and their patients to keep patients informed of their healthcare status. Patient-to-Patient services will support secure interaction among a community of patients with common health information needs.

Our model is integrative from several perspectives. It is built on collaboration between the state Area Health Education Centers, Rural Health Office and the Arizona Telemedicine Program. It incorporates professional and lay health education; rural outreach and telemedicine based clinical services transparently integrated under a collaborative virtual organization - *The Nightingale Consortium*. It incorporates a combined public/private communications infrastructure, fully based on Internet technologies, to overcome barriers to the delivery of health services to rural areas. This model describes a pilot approach in a state with an exceptionally challenging telecommunications environment.

Rather than ad hoc deployment of technologies this model defines an approach that will allow the use of Internet technologies for these services to be evaluated in a controlled environment. Formal evaluation will enhance our capability to deploy services within the framework of HIPAA. The Arizona model is centered on collaboration. Therefore, our model project includes these technologies in the context of both the open (i.e., unsecured) Internet and within the secure Arizona Rural Telemedicine Network (ARTN) operated by the Arizona Telemedicine Program. In this model some AHECs will be involved by connecting directly to the ARTN and others will be involved by connecting via commercial Internet Service Providers (ISPs). Involvement of the operational telemedicine network ensures that we have the participation of physicians who are actively using Internet technologies to provide or utilize clinical services via telemedicine.

We believe a model pilot must include work that will address several emerging areas of interest with respect to Internet based services. These areas include security issues including the use of Public Key Infrastructure (PKI) and Virtual Private Network (VPN) technology; web-based service delivery and the use of IP based video.

General Background
An excellent general background covering the broad scope of underlying issues is provided by A*rea Health Education Centers and the Internet: Issues and Opportunities for Using Interactive Communications to Improve Rural Services*, a discussion paper by Neal I. Neuberger, Mary Ella Payne R.N. M.S.P.H. and Mary Wakefield Ph.D. R.N. The key points relative to this model are the following:

- Broadband access to the public Internet is not ubiquitously available in rural America and there is little business incentive for public carriers to invest in the required new infrastructure. Wireless technologies offer a great potential to overcome some of the investment barriers in rural areas.
- Next Generation Internet (NGI) efforts such are vBNS and Internet2 are oriented towards very high-speed fiber-optic based connections (read: extremely expensive). These efforts primarily connect leading edge research institutions in major urban areas and do not address issues of basic infrastructure in rural areas.
- In the telehealth community there is strong interest in developing low-cost, widely applicable solutions with a great deal of interest in home-health. Relevant technologies include H.324 video over standard telephone lines.
- Standards based approaches are a necessity and are a central theme in the Government Computer Patient Record (GCPR) effort involving the Department of Defense, Indian Health Service and Veterans Administration. Key application standards include HL7, DICOM, and CORBAmed.
- Clearly there is a great deal of innovation taking place in the development of new types of healthcare and health education services for delivery over networks based on Internet technologies.

The Arizona Context

Arizona presents a dichotomy of both leadership and backwardness in key areas related to healthcare and telehealth. Like many states Arizona has a single predominant metropolitan area (Phoenix) in which the majority of the population can be found. A second major metropolitan area (Tucson) is about 1/3 the population of the major urban area. The remaining communities in the state are all under 60,000 in population with the majority of the communities much smaller even than that. About 25% of the population lives in rural areas. These areas are isolated by geography and a critical lack of services and infrastructure. In rural Arizona the telecommunications infrastructure can nearly be categorized as Third World. According to a recent study the state now ranks close to last in the U.S. (at 37th) in the number of households with telephones[1]. In addition, the unemployment in some of the state's rural communities has recently soared as high as 33.6%. Arizona is not necessarily unique with regards to rural telecommunications. A recently released federal report [2] described the following:

> *This report finds that rural areas are currently lagging far behind urban areas in broadband availability. Deployment in rural towns (populations of fewer than 2,500) is more likely to occur than in remote areas outside of towns. These latter areas present a special challenge for broadband deployment.*
>
> *Only two technologies, cable modem and digital subscriber line (DSL), are being deployed at a high rate, but the deployment is occurring primarily in urban markets. Broadband over cable, which provides most broadband service, has been deployed in large cities, suburban areas, and towns. One survey found that, while*

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[1] Deployment of Telecommunications Infrastructure in Arizona's Rural Communities by Julie Fitzpatrick in collaboration with the Arizona Telecommunications & Information Council, Feb. 11th 2000. http://www.researchedge.com/atic

[2] Advanced Telecommunicatoins in Rural America - the Challenge of Bringing Broadband Service to All Americans - A report by the US Department of Commerce and the US Department of Agriculture, Apr 2000.

less than five percent of towns of 10,000 or less have cable modem service, more than 65 percent of all cities with populations over 250,000 have such service.

In Arizona new communications technologies are deployed first in affluent communities in the Phoenix metropolitan area (e.g., Scottsdale). Often these technologies are never deployed to rural areas. Even old technology such as ISDN is only available in Phoenix and parts of Tucson. The predominant ILEC (incumbent local exchange provider), US West, has just completed a merger with Qwest and was already in the process of selling off 39 rural central offices (COs). The expected buyer for most is Citizen's Communications, however no official agreement exists currently. Qwest will only keep the lucrative urban markets. Under the circumstances neither Qwest nor Citizen's has considered it wise to invest in rural infrastructure. However, the Arizona Corporation Commission has required an improvement in rural communications infrastructure as a condition for approving the merger.

The state, especially in Tucson, was well experienced in the MANAGED CARE model long before much of the nation was introduced to its concepts. Arizona has only a single College of Medicine (at the University of Arizona, Tucson) with the states' primary Health Sciences Library. The state has three Nursing Colleges with one at each of the three state universities. While much of the focus of specialty care is based at the University of Arizona several wealthy retirement communities (Cottonwood, Sedona & Payson) have attracted a significant number of specialists. Two of the "Top Ten" telemedicine programs named by *Telehealth Today* magazine in December 1999 are based in Arizona. These are: the Arizona Telemedicine Program (ATP) and the Northern Arizona Regional Behavioral Health Authority (NARBHA). The NARBHA is a member of the *Nightingale Consortium* established by the ATP and a key partner in the delivery of continuing medical education.

The ATP is a broadly based, multi-disciplinary program based at the University of Arizona. The program has conducted over 6,000 telemedicine sessions since the first rural site was brought on-line in July 1997. Telemedicine sessions include; clinical services; continuing and continuing medical education; technology management and support and administrative sessions. Over 5,000 of the sessions have been clinical service with approximately 40 percent based on real-time interactive video and 60 percent based on store-and-forward interactions. The ATP has supported clinical sessions involving some 49 subspecialties over a diverse community of some 17 sites that include both clients and providers. The top subspecialties are radiology, psychiatry, dermatology and cardiology. Six client sites and two provider sites are involved in supporting the delivery of healthcare in the states' correctional system. Four client sites and two provider sites are involved in delivering healthcare services to Native American populations. To support the communications requirements of the program, especially diagnostic quality interactions, the program established the Arizona Rural Telemedicine Network (ARTN). Being based at a health sciences center with a long history of research and development into the application of computer and network technology to healthcare has given the program access to significant technical expertise. The ARTN is based on advanced ATM technology operating over the most basic digital infrastructure widely available in even Arizona's rural areas—T1 point-to-point circuits. The ARTN followed a distributed, Internet-like architecture and placed ATM switches as network access points in Northern, Central, and Southern Arizona. By operating this infrastructure the ATP is able to deploy advanced services (including QoS) that are not currently offered by major telecommunications vendors and that are not available on the public Internet. As the ATP gained experience operating the network it became clear that the network itself could be a focal point for supporting collaboration and supporting traditional referral patterns in the context of telemedicine. In 1998 the concept of the Nightingale Consortium was announced and a business model was developed for non-ATP providers and clients to become members of the ARTN. There are now six healthcare organizations that are paying members of the network and many others are seeking funds to become members.

The Arizona AHEC system has supported recruitment programs designed to interest young people from rural and medically underserved communities into health care careers, reaching over 129,754 participants. It has also served 5,507 medical residents and health professions students serving clinical education rotations in communities throughout the state. More than 105,000 participants have been served by continuing education and continuing medical education programs based on needs assessment surveys conducted by the AzAHEC. Like the ATP, the Rural Health Office (RHO) is also based at the University of Arizona in Tucson. RHO staff members have been integrally involved with the evolution of telehealth in Arizona, as well as the new federally sponsored Critical Access Hospital (CAH) Program. The Arizona CAH program is in the process of implementing a demonstration program involving IP-video technology to connect the state's critical access designated hospitals for the purpose of accessing education and training opportunities and administrative communications. Phase I of this demonstration will link the RHO to three divisions within the Arizona Department of Health Services which are involved in the implementation of the CAH program: Emergency Services, Licensure, and Planning. The RHO is a member of the Nightingale Consortium and is in the process of implementing a direct connection to the Arizona Rural Telemedicine Network.

It could be considered ironic that given the environment in Arizona telehealth activities should flourish. However, the conditions are favorable if a model of collaboration is followed. A poor infrastructure of expensive, limited availability telecommunications provides an incentive for healthcare organizations that are normally strenuous competitors to collaborate. The selection by the ATP of a telemedicine network infrastructure following the Internet paradigm facilitates scalable growth and the easy adoption of new technologies. The competitive provider environment, along with geographically distributed referral patterns led to the creation of a collaborative model of multiple providers sharing a single network infrastructure. This may be completely unique among telemedicine programs that tend to be built around a traditional hub-and-spoke model with a single provider.

Project Overview

Goals of the Arizona Model

Arizona Model is a ubiquitous, integrated virtual healthcare environment in which any provider can interact with any other provider, any provider can interact with any patient and patients can access health information resources in a seamless, easy to use way and with appropriate protection of privacy and confidentiality, all at affordable costs. Certainly this vision is not unique to Arizona, but Arizona may be uniquely positioned to play a leadership role as a laboratory to evaluate the real-world realization of such a vision.

This preliminary plan defines the Arizona concept of how a pilot project can be used to investigate the efficacy of using Internet technologies to support continued development of this envisioned telehealth environment. The process has already been well established by the Arizona Telemedicine Program and this pilot shows how the AHECs and CAHs fit into the process. A manageable scope for a pilot includes the deployment of three types of Health Information services: Provider-to-Provider Information Services; Provider-to-Patient Information Services and Patient-to-Patient Information Services by the AHECs and RHO. Provider-to-Provider services will support secure interaction between providers to enable them to consult regarding the healthcare of specific individuals. Provider-to-Patient services will support secure interaction between providers and their patients to keep patients informed of their healthcare status. Patient-to-Patient services will support secure interaction among a community of patients with common health information needs.

An important aspect of a pilot project will be to analyze the differences between an AHEC based approach to patient-to-patient based services and existing web-based health information resources organized on an ad hoc basis by patients and patient advocates. It will be important to look compare the services described here with commercial web sites such as WebMD. Recent discussion about the imminent financial failure of DrKoop.com may demonstrate the continued need for public participation in rural health even in the "dot com" era.

The Logical Framework

To understand the model pilot project, a generalization of the AHEC Program Model is illustrated in Figure 1.. The model is modified to place the AHEC program within the context of Arizona's developing telehealth infrastructure. The original model, consisting of just the upper three boxes, describes a relationship between academic health centers and community based organizations. In this relationship the AHECs serve to mediate or facilitate the effective interaction between the academic health centers and the communities. That is, the original model describes "what" AHECs do. The expanded model adds the "how" by describing three layers of operational services that facilitate the communication between the entities in the model.

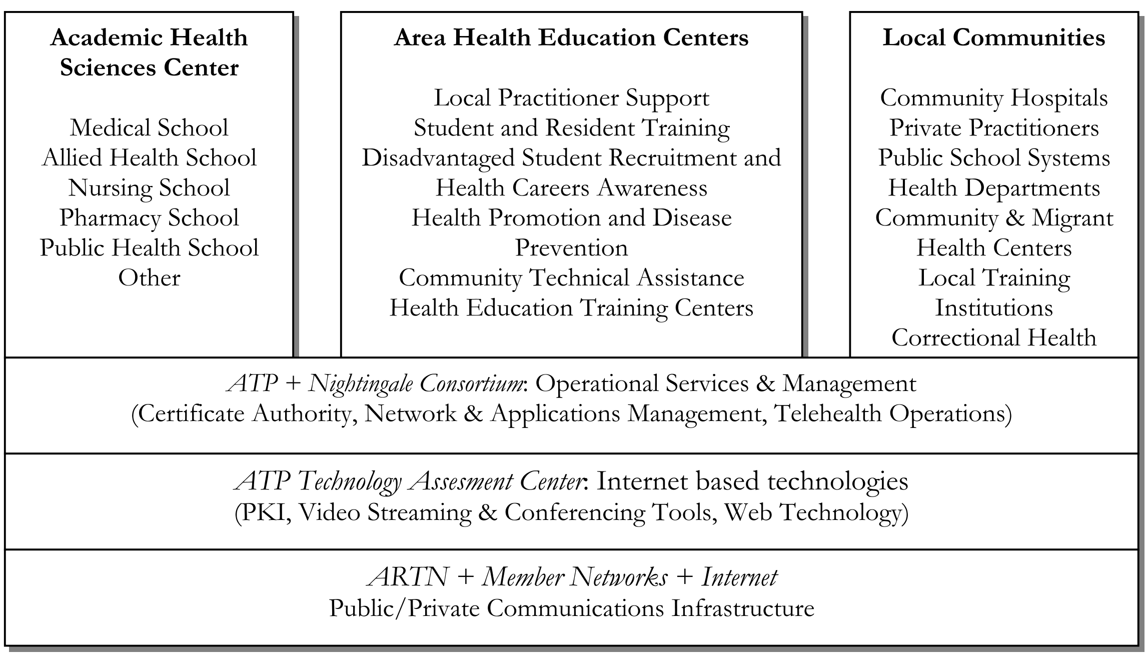

Figure 1. Arizona Program Model

These three layers are arranged, top-to-bottom, to transition from operational services down to technical details and serve to demarcate the points at which services may be selected from different providers. In the case of the Arizona Model the text in italics indicates the likely service provider for an integrated telehealth environment. The enhanced AHEC model is a framework for a developing clinical, educational and public health services in a unified, scalable approach. Note, that it would also be possible to develop this model in a standards based format (e.g., RM-ODP) and further refinement may be done by considering the HL7 Reference Information Model (RIM).

The Operational Services & Management layer captures the requirement for managing the high level services that support the clinical, educational and administrative applications of the collaborating organizations. . An integrated telehealth environment will require significant coordination and management efforts and those functions are placed at this layer. For example, the deployment of Public Key Infrastructure requires the development and management of a Certificate Authority (CA) hierarchy. The CA is responsible for issuing and managing digital certificates (including digital signatures) including the critical function of revocation. CA hierarchies can be completely private (within an organization), completely public (e.g., using a company such as Verisign) or a combination. In order to ensure the security and confidentially of patient interactions across a network this management will be a critical issue. Who will issue certificates to providers, or to patients? In the Arizona Model we envision this may develop as a role of the ATP, probably with some components handled by the RHO or AHECs, as the umbrella for the state telehealth effort. It could also be determined that such activities will be handled by other state agencies such as the state department of health services.

Below the Operational Services and Management layer is the Internet-based technologies layer. This layer represents the necessary functions of evaluating and assessing the efficacy of Internet technologies. The Arizona Model has a strong foundation of assessment and a commitment to evaluation before deployment to validate the clinical efficacy of any technology used for telehealth services. Many of the organizations collaborating in an integrated telehealth environment are not staffed to provide these services. It may be possible to outsource some of these services to emerging Applications Service Providers (ASPs). It is also likely that these functions can be distributed among multiple participants, under the coordination of the upper management layer.

The lowest layer is the communications infrastructure that supports the transport of information among the participants. This layer, certainly in Arizona, can expected to be a combination of public and private networks as appropriate for geographical location and availability of services. For example, the existing ARTN links private networks such as NARBHAnet, member hospital networks and the public Internet. As long as networks are based on open standards interoperability will be possible. At this layer the issues are predominately technology related and it is important to have appropriate expertise (either in-house or out-sourced) to ensure development is scalable and meets the applications requirements of telehealth. For the ARTN the ATP was able to access experts in the field of computing and networking who had extensive experience in the healthcare environment.

The Technological Foundation of the Model Project

The Arizona Model is based on collaboration facilitated by a common communications infrastructure. This model is in fact based on the use of an "internet," or more precisely an internetwork.

An internetwork is simply the interconnection of multiple independent networks (called *Autonomous Systems* in network terminology). In the case of “the Internet” this internetwork is based on a common suite of protocols usually called TCP/IP. TCP refers to the most commonly used transport layer protocol (Transport Control Protocol) which provides reliable, connection oriented end-to-end transport of digital data across a simple LAN (Local Area Network) or an international internetwork. A second protocol, less well known in the poplar media but none-the-less a workhorse, is UDP (User Datagram Protocol). This protocol provides unreliable, connectionless communications services. IP refers to the “Internet Protocol” and is a network layer protocol that provides a “best effort”, packet switched communications infrastructure which supports the interconnection of multiple autonomous systems. The transport layer services utilize IP to provide end-user applications with the capability to exchange information across an internetwork seamlessly. The TCP/IP protocol suite developed by the computer science community out of DARPA funded research in the 1970s intended to enable the exchange of computer data by researchers at several universities involved in defense related projects.

Below the IP layer (i.e., subnetwork) are generally two layers which deal with controlling access to physical media and with the actual physical signaling process (whether electrical, optical or microwave). In most LAN environments these lower two layers are usually based on standards commonly lumped under the popular name of “Ethernet.” The original standard specified a shared-media, local area communications network operating at 10 Mbps. Subsequent standards have pushed speed to 100 Mbps (“Fast Ethernet”) and 1,000 Mbps (“Gigabit Ethernet”). The development of the original protocol was led by Xerox Research Park as part of a consortium of computer equipment vendors. Contemporary competing protocols, Token Ring and Token Bus, were commercially implemented but did not achieve the universal success of Ethernet.

Unfortunately, the physics of communications do not allow these lower-layer protocols to be used across WANs (Wide Area Networks). The original DARPA work was based on unreliable, slow dial-up lines to cross the country. This is why IP was designed to be a “best effort” datagram based protocol. Currently much of the Internet traffic is carried across WANs which utilize Asynchronous Transfer Mode (ATM). ATM was developed by the telecommunications industry during the 1980s as the core of a next generation network to replace the old Public Switched Telephone Network. Technically ATM consists of two major layers—the ATM layer and the ATM Adaptation Layer (AAL). The AAL sits on top of the ATM layer and provides the facilities to allow end-user applications to communicate across an ATM network. Depending on perspective the AAL exists at the same functional layer as TCP while ATM exists at the same functional layer as IP. However, in terms of functions performed ATM is much more limited and simplified that IP. The strength of ATM is that it treats all information (voice, video or data) the same way—breaking it up into small fixed length units called “cells.” The role of the ATM layer is simply to switch these cells, at very high speed, from an incoming link to an appropriate outgoing link. An important feature of ATM is its support for Quality of Service (QoS) which guarantees that specific types of applications will get the response from the network that they must have. This is especially true for synchronous applications such as video. Considering the simplicity of ATM services it is common to view AAL and ATM as sub-network layers and place TCP/IP on top of ATM. This is how most of the major Internet backbone providers transport TCP/IP traffic. ATM provides the WAN links and is used to connect routers that understand the IP protocol. With this approach the carriers can also provide other types of services (voice and video) over the same WAN infrastructure.

Why does this matter? *The ARTN is an ATM based WAN which supports TCP/IP over ATM for store-and-forward based applications in exactly the same manner as national networks such as the vBNS (a Next Generation Internet effort). Applications such as video are supported directly using ATM virtual channel capabilities to support QoS requirements. This architecture was selected because commercial telecommunications providers in Arizona did not offer the appropriate services necessary to support the delivery of telemedicine to rural Arizona. This continues to be the case outside of the urban area. Therefore, the ARTN is built on the same technology as the public Internet and in fact the ARTN is part of the public Internet. This is the case because the ARTN interconnects several independent organizational networks and allows them to exchange information seamlessly. In addition, the ARTN has a direct connection to the University of Arizona campus network that is in turn connected to one of the major public Internet backbones (Sprint). Given our concerns for the confidentiality of patient information this interconnection to the public Internet is mediated by a Firewall subsystem. The ARTN can be viewed as a part of the Internet that is more controlled and protected than the open Internet.*

Project Components

Participants

AHEC offices in Flagstaff and Phoenix, as well has the Program office in Tucson, will be connected directly to the ARTN infrastructure. These centers are located in the same cities as the ARTN regional switch centers and can be connected at T1 speeds for relatively low cost. This will facilitate their interaction with gateways supporting legacy H.320 video. It will also ensure that some AHEC sites are within the secured network to support testing of technologies such as VPN between secured and unsecured network environments.

AHEC offices in Bullhead City and Miami will connect via commercial ISP over standard technologies as available. Potential technologies include xDSL, wireless and most likely standard dial-up modems. The offices in Nogales and Yuma may follow this technology as well, but there is some potential for collaboration via other organizations that are partners with the Arizona Telemedicine Program. In Yuma, the state prison complex about 15 miles south of Yuma is a member of the ARTN and discussions are in progress for connecting Yuma Regional Medical Center. There is a potential for collaboration with the deparment of corrections to facilitate a link for the AHEC. In Nogales the AHEC is adjacent to Holy Cross Hospital, a member of the Carondelet Health Network. One of the Carondelet hospitals in Tucson is also a member of the ARTN and Carondelet operates a network linking its hospitals. It may be possible to link the AHEC via an appropriate interconnection between the ARTN and the Carondelet network.

The Arizona Telemedicine Program is the umbrella organization for state telehealth efforts in Arizona and operates the Arizona Rural Telemedicine Network. ARTN personnel will manage the operational and network service issues, including interactions with ISPs and telecommunications service providers. The Rural Health Office is already a member of the network. Collaboration with the ATP also provides access to rural and community hospitals that are already using the technology for telemedicine and continuing medical education. Many of these hospitals provide the training ground for rural rotations for residents, nursing and pharmacy students from the University of Arizona.

Functional Demonstrations

IP Video Conferencing for Information/Education/Administration: Current telemedicine programs, including the ATP, are primarily utilizing H.320 based video conferencing designed for circuit switched networks (e.g., ISDN). These systems clearly support the quality required for diagnostic clinical activities and there is a broad base of private and commercial infrastructure facilitating this equipment (e.g., video bridging services). The problem is that 1) the circuit switched services are not universally available and 2) the equipment is prohibitively expensive for many of the rural health care providers most in need of telemedicine. Prices are typically over $10,000 and though they have certainly improved they remain relatively high and organizations often end up with expensive, under-utilized equipment. One potential solution strongly advocated by the Internet community is the use of H.323 based video conferencing designed for packet switched networks (e.g., The Internet). These systems have the advantage of relatively low cost (~$1,000) for low-end desktop add-on systems. In organizational environments where high-speed (10+ Mbps) network connectivity is common these system overcome the lack of QoS with raw bandwidth. Within a hospital, a university campus or a dense urban area the public infrastructure may support the use of these techniques even for diagnostic clinical applications. It should be noted that the efficacy for a wide-range of clinical applications has yet to be fully evaluated. IP video conferencing and video streaming is being rapidly deployed in the educational context and it can be expected that there will be a growing need to formally assess its effectiveness. The AHECs offer a rich laboratory for analyzing the efficacy of these technologies for health information access, and health education, across a diverse population of providers and patients. Our model for a pilot project will include the use of IP Video conferencing and video streaming for collaboration among AHECs and to originate educational material from the AHEC program office. This technology will be tested in the LAN environment, the controlled ARTN WAN environment and through firewalls to the open Internet.

Secure Web-based Provider-to-Provider Service: Web based discussion servers may provide a valuable resource for provider to provider consultation. In order to enable discussion of specific case details this service must be provided in a secure environment. This requires authentication of users (providers), secure communication of the information across the network and a secure environment for servers supporting the delivery of this service. Using Public Key Infrastructure technology requires management of digital certificates and establishment of an appropriate hierarchy. The existing relationship of the AHECs with providers suggests they are a logical choice to play a role in the deployment of this technology and to help support the providers in their adoption of the technology. Providers should feel comfortable turning to the AHECs to help them learn how to work with secure, network based tools. Our pilot would include the deployment of a web discussion server for providers, the establishment of an appropriate certificate hierarchy and development of the policies for managing the issuance and revocation of certificates allowing access to confidential discussion groups.

Secure Web-based Provider-to-Patient Services: Just as Web based discussion servers can be applied to provider-to-provider interactions they can be utilized by patients to access providers. We need to do this in a trusted environment and the digital certificates again play an important role. In this case not only do providers have to be authenticated, but patients do as well. If we are to facilitate a patients ability to interact with providers regarding their own specific healthcare issues it is necessary that the patient be authenticated before access is granted to medical information. This will require patients to be included in the certificate authority hierarchy. A possible approach would be to have each individual health care provider issue certificates (probably based on smart cards) to patients. A more efficient approach may be to have an independent organization responsible for the management of digital certificates for patients. The organization should have a relationship with multiple providers to enable a single patient certificate to be used universally by all providers from which that patient may obtain services. The AHEC may play an important role in this process, especially with regard to educating both providers and patients about the benefits of such a system.

Secure Web-based Patient-to-Patient Services: Similar to the services described above it is envisioned that a pilot project should include the capability to provide patient services which enable those patients sharing common health care issues to communicate with each other. A secure server can facilitate this effort. As with other secure services, providing confidentiality requires the issuance of digital certificates to patients and the management of those certificates, as well as training regarding their need and use. A pilot evaluation of this technology can utilize the AHEC sites as a location for patient access to these resources since each patient may not have Internet access and will likely not have appropriate readers on their home PC for smart-card base authentication.

Technology
Network Infrastructure and Management: In this pilot the Arizona Telemedicine Program will support the underlying network infrastructure and management of communications services, whether public or private, within the context of the statewide telehealth environment.

Video Technology and Services: Desk-top video conferencing equipment will be deployed to all AHEC offices for appropriate staff and with one or more systems set up for public access. Operation of these systems will be management by RHO technical staff in collaboration with the ARTN personnel. Interoperation with the existing infrastructure of H.320 equipment will be facilitated by deployment of an H.323/H.320 gateway. This will allow the AHEC to participate in the existing infrastructure of video based CME/CE activities.

Certificate Authority Services: The AHECs and RHO will play a leadership role in establishing an interim policy for the certificate hierarchy necessary to support confidential access to the services described above. They will also play a crucial role in educating health care professionals and the patient population regarding this technology and its application in health care. The appropriate CA publication services will be managed by ATP personnel at the ARTN network operations center.

Project Evaluation

Evaluation Team
Who will evaluate the results to see if this worked?

Data Collection
How will data be collected? The web servers facilitating the information services will be located at the RHO and/or AHECs. Log files will record the hits on the sites to provide information about how often the resources are used. Access to these servers will be restricted to protect the confidentiality of patient information stored on the servers. Authorized personnel (e.g.,

physicians) may review the information to gather research on specific types of cases for which the services have been utilized.

Project Timeline and Budget

The full deployment and evaluation of this pilot project would (ideally) require a 3-year period. This will provide adequate time for proper gathering of detailed requirements, system design, deployment, training and assessment. A detailed budget must be created but $300,000/yr may be reasonable (probably excluding overhead).

Sustainability

The issue of sustainability is critical to developing the envisioned Arizona Model and in this area the ATP has certainly gained a great deal of experience with approaches that can lead to reduced reliance on state funding. This is an important step in the direction of self-sustainability. Of course we would like to rely on the private sector to fully support this environment, but there are a number of public policy issue that will have a critical impact on whether that can happen (esp. reimbursement policies).

Ultimately, sustainability comes down to recovering the cost of providing the service to the public. Taking the approach of using off-the-shelf commercial equipment is one facet. Another is the use of low-cost Internet access where available. For those areas where such access is not available the collaborative approach developed by the ATP helps to make appropriate shared resources available with cost sharing. In addition to these methods there may be an opportunity for revenue generation by giving commercial pharmaceutical companies, and even health care providers themselves, the opportunity to utilize screen space on the web-based information services described in this project. It is doubtful that the "market" addressed in this pilot project would attract enough such support to eliminate the need for other support, but coupled with the other techniques described here there is a strong potential for achieving sustainability. An important aspect of the pilot is the evaluation, through experience, of these potential methods.

Future Development

How does Arizona build on such a pilot project? A positive evaluation result from such a pilot project will clearly demonstrate the feasibility of utilizing Internet based technologies to deliver a wide range of health, health education and public health services. The evaluation of these modes of interaction will be conducted under a rigorous methodology rather than simply relying on the "market place". The successful demonstration project could propel further acceptance of the technology among both patients and providers, and will establish the foundation for widespread adoption of PKI technology in the Arizona Model of telehealth.

How does such a project benefit the national effort? The results will be directly transferable to a fully public Internet based approach that may be pursued by other states. However, the underlying network technology issues are not the most critical. What will be critical, and of intense interest to other programs, will be the issues of policy, management and day-to-day operations. This pilot project would generate a wealth of information regarding the efficacy of using Internet based technologies for delivering information resources and services. Of special importance will be the issues surrounding the establishment and operation of the certificate authority hierarchy, and the deployment of associated technology, to create the secure infrastructure. Since the technology will be common across the Internet the implementation of similar models will depend on appropriate federal and state policies. It is hopeful that the Arizona Model, as demonstrated by a successful pilot, can influence those policies and contribute to the enhancement of rural health nationwide.

Appendix E
Examples of Next Generation Internet Projects

- East Carolina University School of Medicine is addressing technical issues surrounding the implementation of telemedicine and sophisticated medical education using Internet Protocols (IP) video.
- George Mason University Computer Sciences is developing and demonstrating technologies to enable collaboration among multiple, distributed researchers to make progress toward advanced clinical and educational goals.
- The University of Colorado Health Sciences Center is demonstrating and assessing the application of Web-based, 3D-explorable virtual humans to enhance traditional anatomy instruction.
- The University of Pennsylvania is developing a test bed to demonstrate the feasibility of a national breast-imaging archive and network infrastructure to support digital mammography using NGI technologies.
- New York's Columbia University Medical Center has recently received a $28 million award from the Health Care Financing Administration (HCFA) to perform diabetes management and evaluation services for high-risk Medicare patients using Internet technologies and monitoring devices.
- The University of Wisconsin is using WebTV devices installed in patients' homes to provide postsurgical support and management of artery-bypass grafts.

Appendix F
Funding Opportunities for Telehealth Projects

- **Agency for Healthcare Research and Quality (AHRQ)**
  http://www.ahcpr.gov
  AHRQ supports grants, cooperative agreements, and contracts to carry out research, demonstrations, evaluations, and dissemination. AHRQ is primarily interested in health services research, including ways to improve clinical appropriateness and effectiveness. Telehealth and medical informatics projects are often funded through the Center for Primary Care Research and the Center for Information Technology. Even without a specific telehealth or Internet-related funding program, AHRQ has nevertheless funded a number of important extramural research efforts.

- **Centers for Disease Control and Prevention**
  http://www.cdc.gov/od/pgo/funding/funding.htm
  While it has no specific telehealth or Internet program, the Centers for Disease Control and Prevention may occasionally announce grant or cooperative-agreement funding opportunities related to public health and the use of new technologies.

- **Federal Communications Commission**
  http://rhc.universalservice.org
  Expansions to the Universal Service Fund of 1983 under the Telecommunications Reform Act of 1996 established a rural health care support mechanism providing discounts to telecommunications services for rural, not-for-profit health care facilities using telemedicine technology. Eligible rural applicants using high-speed data lines are able to obtain discounted service by applying through the Universal Services Administration Corporation (USAC) on a yearly basis. Limited support is also available for Internet connectivity.

- **Health Resources and Services Administration**
  http://www.hrsa.dhhs.gov
  The Rural Health Outreach Network Development Grant Program, administered through the Office of Rural Health Policy (ORHP), is available to support direct delivery of health care and related services and to enhance service delivery through education, health promotion, and disease prevention programs. Up to 40 percent of its federal funds may be used to purchase equipment. In FY 1999, Outreach funds supported eight telehealth projects.

  The Rural Telemedicine Grant Program, administered through the Office for the Advancement of Telehealth (OAT), will fund 12–15 new awards totaling $5 million in FY 2000 to improve access to care for rural residents, reduce isolation among rural providers, and foster integrated systems of care.

  Since 1989, ORHP and OAT have supported $61.5 million in federal funding for telehealth demonstration and evaluation projects.

- **National Cancer Institute**
  http://www.nci.nih.gov

The National Cancer Institute has a program for the use of multimedia technology to translate research finding into user-friendly health-communication applications for health professionals and the public. The program uses Small Business Innovative Research (SBIR) grants and Small Business Technology Transfer (STIR) grants to support multimedia technology efforts.

- **National Institute of Nursing Research (NINR)**
  http://grants.nih.gov/grants/guide/rfa-files/RFA-NR-01-001.html
  Nursing Research Exploratory Grants are available mostly to schools of nursing that are developing research programs and are primarily used to facilitate the growth of an infrastructure to centralize resources and facilitate specific areas of inquiry. NINR lists "telehealth interventions and monitoring or other emerging technologies to promote patient education for competent self-management and to optimize the effectiveness of treatment" as a funding priority.

- **National Library of Medicine**
  http://www.nlm.nih.gov
  The NLM three-phase Next Generation Internet (NGI) research program was established in 1998 to develop projects demonstrating NGI capabilities focused on quality of service, medical data privacy and security, nomadic computing, network management, and infrastructure technology for scientific collaboration. The National Library of Medicine also has an Internet Connection for Health Institutions Grant Program, which supports grants of up to $30,000 for single institutions and $50,000 for a consortium of public and private nonprofit health institutions to cover gateway and associated hardware costs.

  The Information Access Grant Program"\ provides small grants of up to $12,000 per year for small and medium-size health institutions, including community hospitals, for short-term assistance in achieving access to the delivery of health information through computer and telecommunications technologies.

  The Information Systems Grant Program, as opposed to the Information Access Grant Program listed above, primarily funds academic health centers and larger hospitals in amounts of up to $150,000 for up to three years.

  The Integrated Advanced Information Management Systems Grant Program supports institution-wide computer networks that link and relate to library systems for a variety of individual and institutional databases and information files relating to patient care, research, education, and administration. More than $3.3 million was available in FY 1999, with institutions receiving awards of up to $150,000 per year for two years to a total of up to $500,000 over five years.

  NLM funded 19 multiyear projects in 1996 to serve as models for evaluating the impact of telemedicine on cost, quality, and access to health care; assessing various approaches to ensuring the confidentiality of health data transmitted via electronic networks; and testing emerging health data standards. NLM announced two additional projects in 1997 and has said it may entertain further proposals in the future.

- **National Science Foundation**
  http://www.nsf.gov/home/grant.htm
  Overall, the National Science Foundation invests more than $3.3 billion per year in nearly

20,000 research and education efforts in science and engineering. Grants, contracts, and cooperative agreements in the area of telehealth and informatics would most likely be made through the NSF Directorate for Social, Behavioral, and Economic Sciences or the Directorate for Computer and Information Science and Engineering.

- **National Telecommunications and Information Administration**
  http://www.ntia.doc.gov/otiahome/top/index.html
  The Technology Opportunities Program (TOP), formerly known as the Telecommunications and Information Infrastructure Assistance Program (TIIAP) makes grants to a range of state and local government organizations, libraries, colleges and universities, nonprofit organizations, and other entities to fund networking equipment, computers, videoconferencing, and software; train staff; to purchase communications services; and for other purposes. In 1999, 13 of 43 awards were made for telehealth projects. Since its inception in FY 1994, the program has funded a total of 421 grants totaling $135.8 million.

- **Office of Rural Mental Health Research (ORMHR)**
  http://www.nimh.gov/grants/index.htm
  ORMHR has funded telepsychiatry research grants to stimulate research and demonstration projects in the uses of telecommunications for the delivery of mental health services in rural areas.

- **Rural Utilities Service**
  http://www.usda.gov/rus/dlt/dlml.htm
  The Rural Utilities Service of the Department of Agriculture has administered the Distance Learning and Medical Links program since 1993. The program helps rural schools and health care providers invest in telecommunications facilities and equipment. Since its inception, DLT has funded 306 projects in 44 states totaling $83 million. The Rural Utilities Service operates both a competitive grant program and a loan program for combined financing options. While the RUS program primarily funds hardware, other expenditures such as software, training, and technical assistance may also be considered.

- **Private-Sector Sources**
  http://telemed.calhealth.org
  The California Telehealth & Telemedicine Center has established a grant program through the California Endowment for not-for-profit organizations to support new health-education efforts in underserved communities and for improving access to health services. The center also recently announced a new grant program to provide assistance for telemedicine-based diabetic retinopathy screening for Indian health clinics in California.

  Additional information regarding private sources of funding, including venture capital and foundation support, may be found at the National Venture Capital Association http://www.nvca.org and through the Foundation Center at http://www.fdncenter.org.

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