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Perspective

Rural Telemedicine: Lessons from Alaska for Developing Regions

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Telehealth is about people and processes, not just about the technology.[1]

ABSTRACT

Alaska shares many characteristics with other rural and remote regions of the Asia-Pacific, including a small population spread over a large area, lack of roads linking villages to hospitals, a significant indigenous population, and a shortage of doctors in rural areas. Communication with village health aides was originally by high frequency (HF) radio. Satellites brought reliable voice communication in the 1970s. Alaska has now introduced the first permanent upgrade to the voice satellite system, known as the Alaska Federal Health Care Access Network (AFHCAN). This satellite-based system is now the world's most extensive telemedicine network, linking 248 sites, including 158 village health centers. This paper examines the approach used to design the network, and includes preliminary findings on utilization of the network and associated cost-savings. It also discusses the U.S. Universal Service Fund subsidy for rural health care facilities. It concludes with lessons learned that could be applicable for other remote and isolated areas and developing regions.

TELEMEDICINE AND TELEHEALTH

IN THE PROGRAMS DESCRIBED HERE, applications of telecommunications in support of health care are referred to as "telemedicine," although some researchers and practitioners prefer to use that term for consultative uses, and the term "telehealth" to refer to applications for continuing medical education, administration and public health services. Information and communication technologies (ICTs) can be used to support health services including the following:

- **Emergencies:** to summon immediate medical assistance; to communicate with emergency vehicles and staff;
- **Consultation:** typically between primary health care providers and district level physicians, or between district physicians and specialists;
- **Remote diagnosis:** for example, transmission of medical data and images, interpretation of data by distant specialists;
- **Patient monitoring:** for example, transmission of patient data from home or rural clinic, often coupled with follow-up through local medical staff;
- **Training and continuing education:** of health care workers, paraprofessionals, physicians, etc.;
- **Public health education:** of target populations including expectant mothers,

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mothers of young children, groups susceptible to contagious diseases, etc.;
- **Administration:** ordering and delivery of medications and supplies; coordination of logistics such as field visits of medical staff; accessing and updating of patient medical records; transmission of billing data, etc.;
- **Data collection:** collection of public health information such as epidemiological data on outbreaks of diseases; and
- **Research and information sharing:** such as access to medical databases and libraries and consultation with distant experts and peers.

THE RURAL CONTEXT

The health sector in developing countries confronts major administrative, quality control, and logistical problems. In general, health care in developing countries must be dispensed by individuals with less training and less backup than their counterparts in industrialized countries. Developing regions typically face severe shortages of physicians, particularly in rural areas. Specialists may be available only in the major cities. Health workers may have only minimal training, or have few opportunities to upgrade their knowledge and skills. Facilities for treating patients may be inadequate in terms of staffing, equipment, and medications. In addition, mortality and morbidity rates are generally higher than in urban areas because of poor sanitation and other environmental conditions, and dangerous occupations.

Although the problems they face are much less acute, rural areas of industrialized countries also face difficulties in recruiting and retaining health professionals, and typically have higher mortality and morbidity rates than urban areas. A federal Office of Technology Assessment (OTA) study cited three problems specific to residents of U.S. rural areas:

1. Health indicators: a disproportionate number of rural people suffer from chronic illnesses; infant mortality rate is higher than in urban areas; the number of deaths from injuries is dramatically higher;
2. Distance from care: lack of transportation and few local providers make it difficult to reach health care facilities; and
3. Poverty: poverty is higher in rural areas (of the United States) than in the nation as a whole.[2]

THE ALASKAN CONTEXT

Geographically, Alaska is the largest state in the United States, covering an immense area of 586,412 square miles, with a total population of 621,400. Approximately half the population lives in Anchorage; only four communities in the state have a population greater than 10,000. Approximately 16% of Alaskans are Native American, including Tlingit and Haida Indian tribes in the southeast, Athabaskan Indians in the interior, Inupiat and Yupik (Eskimos) near the Arctic Ocean and Bering Sea, and Aleuts in the Aleutian Islands. Some 25% of Alaskans and 46% of Alaska native people live in communities of less than 1000 people. The concept of "rural" has a different connotation in Alaska than in many other regions; some 75% of Alaskan communities have no road connection to a hospital.[3] Transportation is by boat along the coast or rivers in the summer, and by bush plane year round, weather permitting.

Alaska ranks 48th of the 50 states in the ratio of doctors to residents, and the vast majority of physicians are located in Anchorage. There are also shortages in many medical specialties. At the village level, health care is delivered by community health aides. They are local residents (primarily women) who receive basic medical training and provide first line care for the villagers. Younger aides typically have high school education; older aides may have less formal education but all read and speak English. Health aides are supervised by medical staff in regional hospitals that are now operated by native health corporations with funding from the U.S. Public Health Service, which is responsible for providing health care for native Americans. More than 575 health aides in 200 villages provide nearly one half million patient encounters per year.[3]

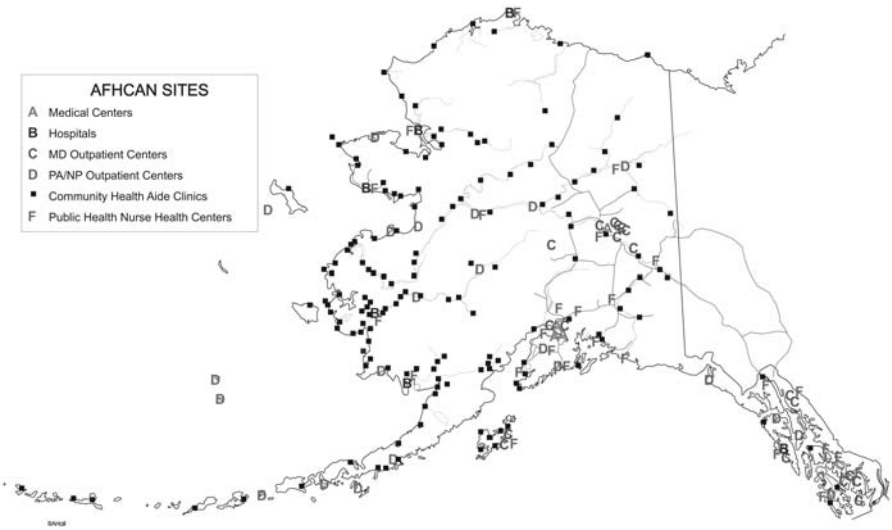

FIG. 1. Alaska Federal Health Care Access Network (AFHCAN sites in Alaska).[6] Photo courtesy of Dr. Stewart Ferguson, executive director of AFHCAN, and Dr. John Kokesh, head of ENT at ANMC.

Communication services to remote villages are provided primarily by satellite because of the vast distances and conditions such as mountains, permafrost and lack of roads that make terrestrial networks impractical. Local telephone service is provided by 25 local exchange carriers (LECs), ranging from major companies with multiple franchises to community cooperatives and small "mom and pop" phone companies. The two major intrastate long-distance companies are AT&T Alascom (the current owner of the original long distance network acquired from the military in 1971 and then expanded) and GCI Inc., an Alaska-based company founded in 1979 that provides voice, video, and data communication services to more than 150,000 residential, commercial, and government customers.

EARLY TELEMEDICINE IN ALASKA

The community health aide (CHA) system was established in 1954, after a U.S. government report stated that, "the indigenous peoples of Native Alaska are the victims of sickness, crippling conditions, and premature death in a degree exceeded in few parts of the world."[4] The program began with training of sanitation aides who returned to their villages to instruct others in maintaining safe drinking water and proper trash disposal. In 1956, the program was expanded to train community aides as firstline health workers. A rural doctor pointed out, "It is not a question of whether the villagers shall be treated by completely qualified medical personnel or persons with less than full qualifications, but a question of whether they shall be treated by persons with limited qualifications or go untreated altogether."[4]

A health aide described those early days, "We had no clinic. We went from house to house taking care of the sick . . . Our tools consisted of a thermometer, a stethoscope, and a blood pressure cuff . . . We had no phones, no radios, but used the school's radio to report our patients. There was no nonsense about confidentiality."[4] However, in 1972, villages in central Alaska began to communicate with a regional hospital and the Anchorage Native Medical Center (ANMC) using a single channel on the National Aeronautic and Space Administration's (NASA's) ATS-1 satellite. The experiment showed that reliable communications could indeed save time and even lives, and that health aides also learned from each other's experiences heard in consultations over the shared audio channel.[5] As a result, the state authorized an expenditure of $5 million for the purchase of satellite earth stations for 200 villages (see Fig. 1) that communicated through RCA's first commercial satellite. Each village had a public payphone and a dedicated audio channel for

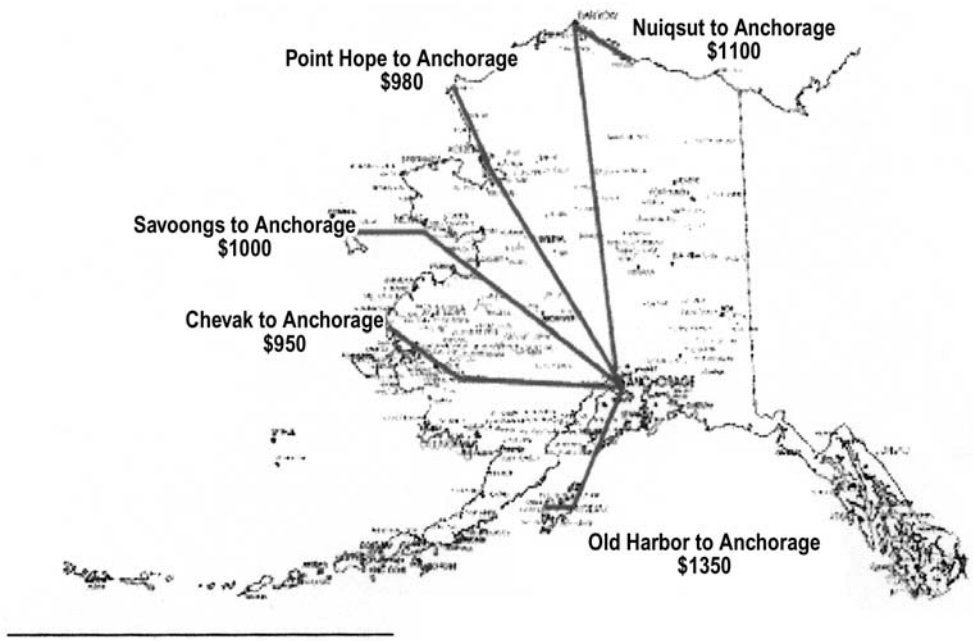

FIG. 2. Examples of airfares in Remote Alaska.[6] Photo courtesy of Dr. Stewart Ferguson, executive director of AFHCAN, and Dr. John Kokesh, head of ENT at ANMC.

health communications, linking the villages with their regional hospital and with ANMC.

TELEMEDICINE TODAY: THE AFHCAN PROJECT

Today, rural native health care is delivered through native health corporations, which in turn receive funding from the Public Health Service, the federal agency responsible for providing health services to native Americans. Community health aides are still the frontline providers of village health care, but a new federally funded project called AFHCAN (Alaska Federal Health Care Access Network) is extending its capabilities through telemedicine, using upgraded satellite facilities that now also provide telephone service for clinics and village residents. AFHCAN provides telemedicine facilities for all federally funded health services in the state, some 248 sites including military installations, Alaska Native health facilities, regional hospitals, small village clinics, and state of Alaska public health nursing stations, affecting more than 212,000 beneficiaries, the majority of whom are in rural Alaska Native villages.[6] Some 38 partner organizations are involved.

Project planners took several steps to design the project to be sustainable. For example, they took particular care to understand the needs of the users (aides and physicians who will use the system) and customers (those who will pay for its ongoing operation). They noted that 67% of the sites have community health aides, and thus made sure that equipment and training were designed for these aides and facilities in village clinics.

Furthermore, they designed the system to address priority medical problems. The Clinical Committee for the project focused on primary care (i.e., treating people in village clinics and similar installations), rather than secondary care (at regional hospitals) or tertiary care (e.g., at the Anchorage medical center). An example of equipment included to address the priority problem of otitis media (middle ear infection, which can cause deafness in children) is an electronic otoscope. They also designed the telemedicine system to be scalable, to adapt to expanded requirements, new applications, and more users.

Technical facilities include centralized and dedicated computer equipment such as servers, a specially designed telemedicine cart and peripherals including a digital camera, electronic otoscope and electrocardiogram (ECG), print-

ers, scanners, routers, wireless networks and customized furniture.[7] The project technical staff chose suitable off-the-shelf equipment wherever possible (such as a rugged and simple-to-use digital camera). Where standard equipment was not suitable, they worked with vendors to make modifications (such as on the equipment cart, which was designed to move easily within the clinic). In some cases, wireless networking was used to avoid attaching long cables to movable carts. Deployment options for the partner organizations included installation by the centralized project, shared installation, or independent installation, that is, the organization procured the equipment from the project but was responsible for its own installation.

After reviewing products from numerous vendors, the project team decided to develop its own software, to run on a wide variety of platforms (Unix, Windows, Macintosh, Linux) and a range of connectivity, from dial-up to T1 circuits. This custom software meets federal security standards for patient data using secure socket layer (SSL), and is designed to minimize capacity for data transmission (e.g., through eliminating retransmission of data already transmitted).[6]

Thus, instead of relying only on verbal descriptions from health aides or sending x-rays to Anchorage, doctors at regional hospitals can now use the AFHCAN network. As noted above, each village clinic is equipped with a personal computer with peripherals including a digital camera, electronic otoscope (for ear infections), and ECG. One common application is for diagnosis of otitis media, a common ear infection among village children that can cause deafness if not treated in time with antibiotics. Health aides can use an electronic otoscope connected to the computer to transmit images of the ear canal. They can also take pictures of wounds, sprains, dermatologic lesions, etc., using the digital camera, and transmit the photo as an attachment to an e-mail message to the doctor. The equipment can also be used to send digitized x-rays. "In the past," stated the information manager of the Maniilaq health center, "there was a big delay in the process. There would be times when the bone would set before a diagnosis could be made. Now, we digitize the film, and it's in Anchorage the same day" (E. Smith, personal communication, May 2003).

The availability of computers in village clinics also makes it possible to use electronic training and reference materials. The Community Health Aide Manual is now available on a CD-ROM. Training materials for operating the telemedicine equipment are online,[6] and the network can also be used for continuing education of the health aides.

UNIVERSAL SERVICE FUND FOR RURAL HEALTH SERVICES

Although the AFHCAN equipment is designed for locations with only a dial-up phone line (or equivalent), most sites now have subsidized broadband connectivity. The Telecommunications Act of 1996 expanded the original purpose of the Universal Service Fund (USF) to extend reasonably priced telephone services to rural and other underserved areas to include support for the cost telecommunications services for schools, libraries, and rural health care providers. In section 254 of the Act, Congress sought to provide rural health care providers, "an affordable rate for the services necessary for telemedicine and the instruction relating to such services." Specifically, Congress directed telecommunications carriers, "to provide telecommunications services which are necessary to health care provision in a State, including instruction relating to such services, to any public or nonprofit health care provider that serves persons who reside in rural areas of that State, at rates that are reasonably comparable to rates charged for similar services in urban areas of that State."[8]

The Federal Communications Commission (FCC) sets the overall policy for the program, which is administered by a nonprofit entity, the Universal Services Administrative Company (USAC). The Rural Health Care Division of USAC administers a program that provides up to $400 million annually so that rural health care providers pay no more than their urban counterparts pay for the same or similar telecommunication services.

Funds come from telecommunications carriers, which are required to contribute a set portion of their revenues to the USF. Carriers gen-

erally pass through these costs to customers through itemized charges on their telephone bills. The FCC makes payments from this central fund to support the Schools and Libraries Program and the Rural Health Care Program, as well as other Universal Service programs that provide subsidies for low-income subscribers and high-cost service areas.

To qualify for universal service support, a health care provider (HCP) must be a public or not-for-profit organization located in a rural area. In addition, not-for-profit HCPs, in both rural and urban areas, may qualify for Internet access assistance if they are unable to access the Internet via a toll-free or local call, and must therefore dial into the Internet via a toll (long distance) call. The HCP may seek support for eligible services, which include mileage-related charges, various types of connectivity from leased telephone lines to frame relay, integrated services digital network (ISDN) or T1 circuits, mileage charges, and one-time installation charges. End user equipment such as computers, telephones, fax machines, as well as maintenance charges, are not eligible for support.[9] All telecommunications common carriers may participate, including interexchange carriers (IXCs), wireless carriers, and competitive local exchange carriers.

Each eligible HCP requests bids for telecommunications services to be used for provision of health care through postings on the USAC website. Requests for bids must be posted on the USAC website for 28 days before the HCP can enter into an agreement to purchase services from a carrier. The HCP must consider all bids received and select most cost-effective method to meets its health care communication needs.* Although Alaska has been a major participant in the health USF program, by 2003, only 1194 of 8300 potential applicants had received support, and the fund disbursed only $30.25 million in first five years out of a potentially available $200 million. Therefore, in 2003, the FCC implemented several changes to eligibility requirements and comparative pricing guidelines designed to make the USF discount more widely available and simpler to implement.[10]

*The Federal Communications Commission (FCC) defines "most cost effective method" as "the method of least cost after consideration of the features, quality of transmission, reliability, and other factors relevant to choosing a method of providing the required services." See www.rhc.universalservice.org

LESSONS LEARNED FROM AFHCAN

The AFHCAN network is still in its early days, and results of analysis of patient encounters are preliminary. However, there are already several findings from this project that are relevant for other rural and isolated regions, including the mountainous areas and scattered islands of the Asia-Pacific.

Saving time

Telemedicine links between a community health aide and doctor at a regional hospital can enable patients to be seen quickly who would otherwise have to wait for a visiting doctor or for arrangements to be sent to a regional clinic. The following feedback from a regional physician is illustrative, "We have done about 150 telemedicine cases at this point, patients who would have normally been placed on a waiting list to be referred to the regional ENT clinic. Waiting times range from 2–6 months. . . . We review the cases and make recommendations within 24 hours."[3] Turnaround times for teleradiology have also greatly decreased for diagnostic interpretations from 9 to 21 days to within 24 hours, and immediate response for emergencies.

Improving quality

Early diagnosis may prevent deterioration of patients' conditions. Such consultations may also be valuable for preventive care. Analysis of cases will be required to determine impact on treatment and outcomes. Concerning telegradiology, village clinic imaging is performed by midlevel staff, health aides, and sometimes clerical staff. Training that is focused on taking x-rays has improved the quality of images seen by the radiologist.[11]

Saving money

The AFHCAN system can save money as well as time. Preliminary analysis of cases showed that 29% of consults prevented travel by the patient to a hospital.[3] Earlier analysis of a pilot network

similar to AFHCAN found that an evacuation by plane can cost from $10,000 to $25,000. The package of computer, peripheral equipment, and training is estimated to cost $22,000, so that if it saved two evacuations, it would pay for itself (F. Pearce, personal communication, August 1999).

Even when medical evacuations are not required, scheduled transport to a regional hospital can be very expensive. Rural residents travel an average of 147 miles one way for the next level of care. The cost of roundtrip airfare to a regional center may be $600 or more. Roundtrip airfares to Anchorage from a village may exceed $1800 (see Fig. 2). AFHCAN evaluation data indicate that telemedicine obviated the need for travel 37% of the time. Extrapolated to 13,307 through 2003, encounters, the result is over $2.8 million saved in airfares alone (see www.afhcan.org/about/costsqualityaccess.aspx). An additional social benefit is that patients who can be treated locally do not have to leave their home communities.

However, it should also be noted that a telemedicine consultation may cause patient travel because a serious problem is identified that would have been missed by the health aide. Approximately 8% of the analyzed patient consults resulted in patient travel. (These findings are remarkably similar to data from the ATS-1 satellite telemedicine experiment evaluated by the author and colleagues 32 years ago.)[5]

Involving the users

An assessment of the AFHCAN project in 2001 noted that, "telehealth is about people and processes, not just about the technology."[1] Accordingly, it recommended an increased emphasis on staff and organizational issues including the following:

- Shift focus from deployment to increasing usage and operational success;
- Increase cooperation and sharing (of expertise) among participating organizations;
- Identify clinical needs to use equipment;
- Develop comprehensive training plan for various users (from physicians to health aides), etc.

In general, these recommendations have now implemented. Also, a help desk and technical support system have been established.[12]

Designing for sustainability

The AFHCAN planners selected or adapted equipment that is rugged to withstand field conditions such as power and temperature fluctuations and cramped space, and easy to use (taking into consideration the likelihood of high staff turnover and need for retraining). They attempted to minimize capital and operating costs by choosing low cost (but highly reliable) equipment and transmitting data (digital pictures, ECG, patient information, etc.) primarily in store-and-forward mode.

Using incentives for universal service

An important element of the USF program is that it is designed to be incentive-based. Subsidies are not awarded directly to the carrier but to the user (i.e., health care providers are eligible to receive the discount). Similar to a voucher system, the fund can empower rural health care providers, because they now have resources for technology. Thus, an Alaskan telecommunications official noted that the USF created a competitive environment in Alaska that is vendor neutral, puts the power of choice in the hands of the consumer, and offers a subsidy program that attracts long term capital investment.[13]

Stimulating innovation in telecommunications services for telemedicine

Both the AFHCAN project and the funding available for rural telemedicine under the USF have stimulated innovation by a major telecommunications carrier serving Alaska. GCI, a regional integrated services provider headquartered in Anchorage, has contracts to provide satellite connectivity for telemedicine in several isolated regions of Alaska. Experience providing these services led GCI to design a secure network called ConnectMD designed to provide Alaska's medical practitioners with secure, reliable connectivity for transmission of patient information using secure Health Insurance Portability and Accountability Act[14] (HIPAA)-enabled connections.[15–16] GCI plans to offer this service to telemedicine providers in other regions.

CONCLUSION

Current telemedicine initiatives in Alaska support health care delivery in other isolated and developing regions. The strategies to plan the project emphasized on primary care and priority needs, and to take into consideration training levels of health aides and village conditions, are critical for developing regions.

Preliminary data indicate that the project is effective in reducing patient travel costs and enabling patients to be treated with the advice of a doctor who may otherwise not have been seen by a doctor or would have had to wait long. Evaluating true cost effectiveness remains difficult, as AFHCAN was funded by a Congressional appropriation, and the cost of broadband connectivity is subsidized by the USF. However, project planners made every effort to use equipment suitable for village settings, and to design applications that could run on narrowband (such as dial-up) circuits. The emphasis on store-and-forward applications and use of simple digital cameras for photographs that can be sent as attachments to email messages are examples of low cost techniques.

Finally, the incentive-based model for provision of universal service also appears appropriate for isolated and developing regions. Rather than requiring providers to serve remote areas at a loss, the USF mechanism offers a least-cost subsidy for providers who can demonstrate capability to provide designated services. The availability of a subsidy for Internet connectivity to schools and rural health centers can result in these locations becoming "anchor tenants" for a carrier in a community, creating an incentive to then extend the service to other locations.

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