

# Low-Bandwidth, Low-Cost Telemedicine Consultations in Rural Family Practice

Thomas E. Norris, MD, Gary L. Hart, PhD, Eric H. Larson, PhD,  
Peter Tarczy-Hornoch, MD, David L. Masuda, MD, Sherrilynne S. Fuller, PhD,  
Peter J. House, and Sarah M. Dyck

**Background:** Telemedicine, based on the use of interactive video consultations, is being used more commonly in rural settings. This development is potentially important to rural patients because there are fewer physicians, particularly specialist physicians, in rural areas. Declining costs of telemedicine equipment and transmission have created increased access to these technologies for rural family physicians and their patients.

**Methods:** This study considers satisfaction levels of rural family physicians, academic-based specialists, and rural patients in 130 consultations between rural physicians, rural patients, and urban academic specialists. To increase the practicability for rural use, low-cost equipment and low-bandwidth digital telephone transmission lines were utilized. Data were collected using questionnaires that were completed by patients, family physicians, and specialist consultants after each consultation.

**Results:** All categories of participants noted very high levels of satisfaction.

**Conclusion:** Telemedicine-based consultations are well accepted by rural patients, rural family physicians, and urban academic specialist consultants. This approach could offer a useful adjunct to rural health care. (J Am Board Fam Pract 2002;15:123-7.)

Almost one fourth of the population of the United States lives in rural areas, but only 9% of US physicians practice in these locations. Rural populations have several characteristics in common. Among these are low population density, with more distance between people, as well as a commonly held belief that patients are older and sicker than their urban counterparts. The provision of adequate health care to this group of citizens has been, and remains, a challenge.

One promising approach to this rural geographic access problem has been the use of telemedicine as a means of providing health care ser-

vices to rural patients. The Institute of Medicine defines telemedicine as "the use of electronic information and communications technologies to provide and support health care, when distance separates the participants."<sup>1</sup> A key concept in this definition is distance between the participants, a factor that makes this technology especially useful in rural settings. These systems represent one method of linking urban concentrations of physicians with widely dispersed groups of rural patients and their caregivers.

Efforts to use television as a tool to improve health care are not new. In October 1959, Health, Education, and Welfare Secretary Arthur Flemming spoke to the first meeting of the Council on Medical Television at the National Institutes of Health in Bethesda stating, "The pace of progress in medical science has been matched by advances in communications technology. . . . Television can transcend space and time. . . . Our ever-increasing knowledge of health and disease must be brought into the everyday practice . . . and to the bedside of every patient."<sup>2</sup>

For many of the next 40 years, the use of telemedicine in rural sites languished, flourishing only when grant funding was available. Recently, technological advances and price reductions both in

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From the Office of the Dean (TEN), the Department of Family Medicine (GLH, EHL) and WWAMI Research Center (GLH, PJH); the Department of Pediatrics, Division of Neonatology (PTH) and the Division of Biomedical Informatics (PTH); the Department of Medical Education (DLM, SMD); the Division of Biomedical and Health Informatics and Health Sciences Libraries (SSF); and Regional and Rural Education (PJH), University of Washington School of Medicine, Seattle. Address reprint requests to Thomas E. Norris, MD, Office of the Dean, Box 356340, School of Medicine, University of Washington, Seattle, WA 98195-6340.

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computing and communications equipment and in transmission charges have made the use of these tools more feasible. As a result of these advances, coupled with new federal grant programs, the use of telemedicine has started to spread rapidly. Unfortunately, assessment of telemedicine, especially of applications of telemedicine to rural sites, has lagged.

The WWAMI (Washington, Wyoming, Alaska, Montana, and Idaho) Rural Telemedicine Network was established in 1994 (first consultations in 1995) with funding from a grant from the Federal Office of Rural Health Policy. The network was designed to provide remote rural primary care providers with consultative access to specialists based at the University of Washington Academic Health Center. Since its inception, eight sites in five states have been developed. Because many rural communities lack both extensive financial resources and high-bandwidth digital transmission capabilities, the network was designed to use low-bandwidth, low-cost, personal-computer-based systems for its consultations.

The intent of the WWAMI Rural Telemedicine Project was to show the functionality of low-bandwidth, low-cost telemedicine consultations between primary care providers in remote rural settings and academic specialists, and to assess the satisfaction of patients, rural family physicians, and urban specialists with such a system.

Gustke and her colleagues<sup>3</sup> have recently reviewed patient satisfaction with telemedicine. They note that there are only about 12 published studies on patient satisfaction with telemedicine applications. Of the 12 studies reviewed,<sup>4-15</sup> only 2 dealt specifically with rural populations. Of these 12 studies, the patient satisfaction levels were quite high (average 92.8%). Gustke and colleagues' own study found 98.3% patient satisfaction.

## Methods

The University of Washington (UW) Academic Health Center, located in Seattle, serves as the only medical school and academic medical center for the five WWAMI states. Three UW teaching hospitals, Harborview Medical Center, the University of Washington Medical Center, and Children's Hospital and Regional Medical Center, serve as the urban specialty hubs in the WWAMI Rural Telemedicine Network. Eight rural sites (Colville, Fri-

day Harbor, Pomeroy, and Toppenish, Wash; Driggs, Idaho; Ronan, Mont; Petersburg, Alaska; and Thermopolis, Wyo) serve as the spokes in the network. Although this system generally functions as a hub-and-spoke model, it is not closed; the rural sites have access to any dial-up telehealth services provider they chose. Primary care physicians in the rural sites are almost all family physicians. They provide care to a large number of rural patients, most of whom are located long distances from urban specialists. Consultations with specialists at the University of Washington occur by means of both interactive real-time video consultation and store-and-forward consultations.

The consultations reviewed in this study were limited to real-time interactive video teleconsultations. Although almost all specialties were available, the most common consultations were in the areas of cardiology, dermatology, psychiatry, orthopedics, radiology, and rheumatology. Consultations with most specialties were available within 1 to 2 weeks. The patients were not charged for the consultations included in this project. Payments for both the primary care and specialty portions of the consultations were provided by the grant that funded the project.

The rural telemedicine units consisted of a personal computer (PC), videocamera, software, stethoscope, fax machine, and modems. At a time when studio telemedicine units cost \$75,000 to \$150,000, the average cost for a rural unit in 1995 was \$11,000. This system had the capability of providing both two-way interactive video consultations and store-and-forward asynchronous consultations. If a digital scanner for radiographs was included in the system, the price increased by \$16,000.

Instead of using expensive (and often unavailable) high-bandwidth T-1 digital telephone lines, transmission was achieved using low-bandwidth links with paired switched-56 lines (112 kB/s) or (rarely) slightly higher bandwidth ISDN (Integrated Services Digital Network) lines (128 kB/s). These digital telephone lines were the lowest level capable of providing the bandwidth needed for interactive real-time video consultations, and these lines were usually available in rural sites.

A three-part evaluation tool was developed for this study, with one part each for the patients, the rural primary care physicians, and the urban specialists. The tool was created and pilot tested by

**Table 1. Percentage of Satisfaction with Telemedicine Consultation.**

Respondent	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied
Patients	88.6	11.4	0.0	0.0
Local providers	95.7	2.6	0.9	0.9
Consultants	70.9	26.8	1.6	0.8

researchers at the WWAMI Rural Health Research Center.

A total of 130 real-time interactive video teleconsultations are represented in this series. There were 107 survey results provided by patients, 119 by local primary care providers, and 130 by consultants.

The normal pattern followed in this study was to have the primary care provider see the rural patient in the normal fashion. If a problem required consultation, then the physician would inform the patient that the alternatives for the consultation were the routine approach requiring travel by the patient to the distant specialist or the use of a telemedicine consultation. If the provider and patient selected telemedicine, the primary care provider, who also notified the project coordinator to schedule a consultation, obtained consent. The coordinator would arrange the consultation with the patient, the primary care provider, and the specialty consultant. Both the patient and the primary care provider would be present at the rural consultation site (usually at the rural clinic or the rural hospital), and the specialist would be present at one of the four sites in the academic medical center hospitals. After the consultations were concluded, the patient, the primary care provider, and the specialist completed satisfaction questionnaires. Although the questionnaires for each consultation were linked to allow analysis of all aspects of a particular consultation, the patients' identities were kept strictly confidential.

The results reported here represent the complete results from this group of patients, local primary care providers, and academic medical center based specialist-consultants for the 3-year data-collection phase of this project. Other than calculating percentages, no statistical manipulation or analysis was performed on the data.

It is noted that many of the telemedicine consultations in this project took place across state boundaries. The need for medical licensure by the consultant in both the state where the consulting

physician is located and the state where the patient is located has been a barrier to interstate telemedicine consultations. In this study the licensure problem was addressed by obtaining special permission from the state licensing boards to conduct this experimental endeavor. The boards granted the permission, at least in part, because a locally licensed primary care physician was present with the patient during the consultation.

## Results

Both rural primary care providers and urban consultants were queried about the purpose of the telemedicine visit—more than one answer could be selected. According to the primary care physicians, 77% of the consultations were for assistance with diagnosis, whereas 65% were for assistance with treatment. When asked the same question, the consultants believed that 71% of the visits were for diagnosis and 61% involved assistance with treatment. The vast majority (> 97%) of the telemedicine interactions were classified as routine, not emergent, by both the consultants and the local providers.

Of particular importance, the consultations were considered medically necessary by the consultants in 128 (98.5%) of the 130 cases. Similarly, the local providers were asked how they would have managed the case if a telemedicine consultation had not been available locally. In the absence of telemedicine, 52% of the patients would have been referred to a nonlocal provider, and the local provider would have sought informal consultation in another 22% of the cases.

Perhaps the most critical question asked on all the questionnaires (local providers, consultants, patients) concerned the respondents' satisfaction with the telemedicine consultation. As shown in Table 1, the results were uniformly and overwhelmingly positive.

Another important question asked of both the consultants and local providers was to compare the

quality of the care the patient received during the telemedicine visit with that of an in-person consultation. Among the consultants, 64.0% ranked the care as about the same, whereas 19.2% responded that telemedicine was better, and 16.8% responded that it was worse. Of the local providers 43.6% selected about the same, whereas 29.1% found it better, and 27.4% found it was worse. It is noteworthy that more of the rural providers responded that the telemedicine consultations were better.

Both local providers (78.6%) and consultants (92.1%) agreed that the telemedicine visits usually resulted in the patient avoiding travel to visit to a nonlocal consultant. There was also overwhelming agreement between the local providers (99.1%) and the consultants (92.3%) that the telemedicine consultation resulted in better care than the patient would have received with a telephone-only remote consultation.

In an effort to try to determine the clinical value of the telemedicine consultation, the local providers were asked whether they had changed their diagnosis or treatment as a result of the consultation. In 64.3% of the cases, the rural physicians indicated that the telemedicine consultation had resulted in a change in their diagnosis or treatment.

In a similar effort to determine the value of the telemedicine consultation to the consumer (patient), patients were asked whether they would prefer a local telemedicine consultation to visiting a nonlocal consultant. Most patients, 93.8%, indicated they preferred a local telemedicine consultation to traveling to see a distant specialist. Additionally, 98.1% of the patients queried stated that they would recommend a telemedicine consultation to someone who needed to see a consultant.

## Discussion

Low-bandwidth, low-cost telemedicine consultations that are based in a personal computer platform, not a studio setting, are far from slick. The systems have been described by some of the consultants as clunky, and the quality of the image is far from that seen on network television or at the cinema. If the subject moves rapidly, the phenomenon of pixelization occurs and the image blurs. Because of limitations in access to high-bandwidth digital transmission lines, as well as financial limitations imposed by expensive studio systems, this simple type of interactive video transmission is all

that is available as a telemedicine system to many small rural health care facilities. Few published studies have comprehensively reviewed these low-end approaches. Yet, despite all the inadequacies of the systems, there was overwhelming acceptance of this type of telemedicine consultation by patients, local providers, and academic consultants.

It must be remembered that, in all the consultations presented here, the participants had selected a telemedicine format. Thus, it is possible that the high satisfaction levels could be, at least in part, due to a bias based on the selection that had been made by those who subsequently answered the questionnaires. Furthermore, the health care in this study was paid for by a grant, which could have resulted in higher satisfaction than if the care had been paid for using the patients' usual insurance or other resources. Nevertheless, all agreed that the systems added important value to the consultations, and all believed that the capability of avoiding distant consultations was worthwhile. Clearly, these systems are perceived to offer a useful tool to rural patients and health care providers. Many rural areas, often with locally owned telephone systems (sometimes inadequately resourced), simply do not have access to the broadband T-1 transmission lines commonly found in urban areas. The low-bandwidth systems described here might represent their only alternative for telemedicine services.

An aspect of this type of telemedicine consultation that was not explored in this study is its capacity to provide case-based continuing medical education for rural family physicians. Several of the rural physician participants noted that they often learned new diagnostic and therapeutic skills from their specialty colleagues during the three-way interactions among rural patients, rural family physicians, and urban academic specialists. This unanticipated outcome of the study provides important guidance for future educational efforts.

## Conclusion

This study shows both the utility of and satisfaction with low-bandwidth, personal-computer-based, interactive televideo consultations between patients and physicians based in rural settings and urban-based academic consultants. Until low-cost, broadband digital transmission capabilities are available in all rural communities, systems of the type used in this study offer a useful alternative to support the difficult and lonely task of rural health care.

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