

Provider Acceptance of Telemedicine Systems in Remote Areas of Ontario

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Telemedicine, the use of telecommunications technology to assist in the delivery of health care, is an increasingly popular solution to some of the problems faced by rural residents in obtaining health care. Since September 1, 1977, the Sioux Lookout Zone in northwestern Ontario has been experimenting with slow-scan video equipment as part of its health care delivery system. The attitudes of the providers who use the system were surveyed. The nurses were positive about slow-scan video as an aid in the delivery of health care; however, the physicians were less enthusiastic. This difference can be explained by physicians' having had more extensive training than the nurses, and therefore not feeling the same need for medical backup and support. Both nurses and physicians had more positive attitudes toward the system after experience with it.

Many attempts have been made to bring more comprehensive medical care to underserved areas, including physician incentive plans,¹⁻³ the use of nonphysician providers,^{4,5} and telemedicine.⁵⁻⁸ Unfortunately, many of these solutions are not yet accepted by providers and patients. Physician incentive plans are financially attractive, yet most physicians prefer to live in large cities.¹⁻³

Nonphysician providers can provide high-quality health care, yet people prefer to visit physicians.⁴ The use of telecommunications technology to assist in the delivery of health care (ie, telemedicine) is feasible,^{9,10} yet many providers fail to accept this approach.^{6,11} The acceptance of telemedicine by providers is the focus of this paper.

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The Setting

Prior research^{9,10} has indicated that telemedicine is a feasible approach to solving some of the problems caused by a maldistribution of physicians. Most of this research, however, has been

done under controlled conditions where neither the patient nor the physician was completely dependent on the system. Thus, it was felt that a more valid test of telemedicine should be undertaken in an area of real need.

The site selected for the study was a remote region of northwestern Ontario known as the Sioux Lookout Zone. The area is large (385,000 sq km) and has a harsh climate and rugged terrain. The 10,000 predominantly Cree and Ojibway inhabitants reside in 27 permanent communities that range in size from 25 to 1,000 residents. Only one of the communities can be reached by road, necessitating the use of small bush planes for transportation.

Since none of the communities can attract or even support a full-time physician, the bulk of medical care is provided by nonphysician providers operating out of a series of health aide and nursing stations. The health aide stations are staffed by minimally trained indigenous personnel, who supply emergency care and some basic primary care. The nursing stations are staffed by highly trained nurse practitioners, who provide day-to-day primary care. Each of the 20 health aide clinics is a satellite of one of the seven nursing stations and receives support from its focal station. The nursing stations in turn are backed up by the Sioux Lookout Zone Hospital, which is the medical and administrative center for the area. The Zone Hospital receives specialty support from tertiary centers in Toronto, Thunder Bay, Dryden, and Winnipeg. Typical staffing levels in the zone are 4 family physicians, 18 nurses, and 33 health aides.

Nearly 90 percent of all primary care in the remote communities is administered by the nonphysician providers. The nurses see approximately 32,000 patients per year; the health aides, 8,000 per year. A patient who requires immediate care that is beyond the capabilities of these providers is transferred by plane to the Zone Hospital. These transfers cost about \$350 each. It is precisely for this reason that the slow-scan video system was installed. By giving the nonphysician providers a visual communications network, it was hoped that many of these transfers could be prevented, with the patient being treated remotely under a physician's supervision.

The telemedicine project¹² links five of these remote communities (three nursing stations and

two health aide stations), the Zone Hospital, and two large Toronto teaching hospitals by means of a two-way, slow-scan video network. The choice of slow scan as the technology for the field trial was based on previous research.^{9,10} This work indicated that there were no significant differences among video systems (slow-scan video, black-and-white television, or color television) in allowing physicians to diagnose medical problems. Given this result, the least costly system, slow-scan video, was selected. This technology is less expensive than the others, since it uses regular telephone lines that are already in place in most areas. Once the capital costs of the equipment have been paid (\$15,000 per unit), operating costs are minimal: regular long distance telephone charges and maintenance, which during the project averaged to \$150 per month per station.

The system is capable of transmitting a still-frame black-and-white picture from one location to another over the regular telephone lines. To transmit a picture, the user obtains an image on the screen using a video camera. Typical images include roentgenograms, electrocardiograms, and skin rashes. Once the desired picture is obtained, it is frozen, digitized, and sent to the receiving station by pressing a button. From the receivers' point of view, the picture starts at the left edge of a normal video monitor and fills in from left to right with the arrival of vertical lines from the sender. The transmission of a complete frame takes 79 seconds. Voice communications are handled via a speaker telephone mounted on the wall near each slow-scan unit. When two separate telephone lines are used, voice and image transmission can occur simultaneously, the preferred mode of operation for almost all uses.

The slow-scan video network was designed to enable nonphysician providers in the isolated communities to obtain medical backup from the Sioux Lookout Zone physicians. It also allowed the zone medical personnel to obtain specialty support from the university hospitals in Toronto. Over the three-year research period, 1978 to 1980, there were 532 sessions between the northern stations and Sioux Lookout. The Sioux Lookout-Toronto link was used 429 times during this same period. Use of the equipment fell into three main categories: medical consultations, education, and social and therapeutic contacts. The medical consultations were as one would expect, involving

nurses, physicians, and specialists. Regular educational sessions originated from Toronto for the zone physicians and from Sioux Lookout for the northern nurses and covered a variety of topics. Social or therapeutic contacts were between hospitalized patients and their families back home and were designed to lessen the loneliness and isolation felt by many hospitalized Indians. The use of the system was approximately 36 percent for consultations, 37 percent for education, and 27 percent for social or therapeutic uses.

Methods

Two hypotheses were tested. The first concerned the overall attitudes of the providers toward the technology. The second concerned whether their attitudes toward the system have changed over time. The hypotheses are (1) the present attitudes of the providers toward slow-scan video as an aid in health care delivery will be positive, and (2) the present attitudes of the providers will be more positive than their initial attitudes.

A simple questionnaire designed to obtain before-and-after attitudes was administered by a Zone Hospital nurse in August 1979. All responses were anonymous. Thirty-four nurses and the four physicians who were employed by the Zone Hospital completed the questionnaire. The sample included all of the physicians employed by the Zone Hospital, all nurses in the three communities with the video system, and all hospital nurses who had used the system and were familiar with its capabilities.

Questions were asked regarding prior and present attitudes toward the slow-scan video technology. Five replies were possible: strongly negative, negative, neutral, positive, and strongly positive. Although this investigation was not a true before-and-after study, it was felt that if any bias was introduced by the procedure, the respondents would modify their perceptions of previous feelings to resemble more closely their present attitudes. In particular, such a bias would work against the verification of the second hypothesis.

Several questions were asked to determine

whether the providers felt that a slow-scan video system was useful for various aspects of remote health care delivery. One question asked whether the individual had ever heard of telemedicine before. Other questions determined the length of stay in the zone, frequency of usage of the equipment, and the problems associated with that usage. A blank sheet was attached to each questionnaire for those wishing to make additional comments.

Results

A variety of analyses were done along various dimensions, including zone experience and usage of the equipment, but the results failed to indicate any significantly different subgroups. Another distinction was made between the Zone Hospital nurses and the nurses working in the field. Data analyses again indicated that the response of these two groups were similar. This finding was not completely unexpected, since most of the hospital nurses had worked in the field either full-time or in a backup role.

For these reasons the data reported herein are aggregated except where a distinction is made between the physicians and nurses.

The first hypothesis was concerned with the present attitudes of the providers toward slow-scan video. None of the physicians or nurses indicated a negative attitude toward the system, and 28 of the 38 respondents (73.7 percent) held positive or strongly positive attitudes. Although the sample size was too small for definitive statements, it appears that the nurses were more positive than the physicians. Twenty-six of the 34 nurses had positive or strongly positive attitudes, whereas only two of the four physicians held positive attitudes.

To test the null hypothesis that each respondent was equally likely to have a positive (including strongly positive) or a nonpositive attitude (negative or neutral), a binomial test was used on the overall total. The null hypothesis was rejected ($P < .01$). Provider attitudes were significantly positive toward the system.

For the second hypothesis the prior and present

attitudes of each of the respondents were compared to determine whether they became more or less favorable toward the system over time. Since there were five possible responses, an individual could conceivably show a jump of or decline from one to four categories. All four physicians became more favorable toward the system. Two (5.9 percent) of the 34 nurses became more negative, 13 (38.2 percent) remained the same, and 19 (55.9 percent) became more positive. Of the 19 nurses who indicated an improvement in attitude, 9 indicated a jump of two categories.

To test the hypothesis of equidirectional change in the attitudes of the providers, the sign test was used. The null hypothesis was clearly rejected ($P < .01$), indicating that there was a significant improvement in the attitudes of the providers.

Three other general questions were asked. One asked the providers whether they would include a slow-scan video system if they were managing a remote health care system such as the Sioux Lookout Zone. Of the four physicians, two did not want it while the other two were unsure. Only six (20 percent) of the 30 nurses who responded to this question indicated that they would not want slow-scan video as part of the health care system. Another two (6.7 percent) nurses were unsure, and 22 (73.3 percent) indicated that they would include it.

Another question asked the providers whether they thought that the slow-scan video system was useful for education, social relations, medical backup, and reducing unnecessary transfers from outlying communities to the Zone Hospital. The physicians saw the system as useful for education, social relations, and medical backup. They did not think that it reduced the number of transfers in the zone, however. The nurses agreed that the system was suitable for education, social relations, and medical backup, but, contrary to the physicians, they felt that it would prevent some transfers. Nevertheless, as did the physicians, the nurses ranked this aspect of the system as the least beneficial.

The most common theme among the physicians' comments was that the system would not prevent unnecessary transfers. Their reasons were that the need for most transfers was obvious and that only with hindsight could one tell whether a transfer was unnecessary.

The nurses' comments were markedly different from those of the physicians. Their most recurring

observation concerned the benefits to patients and their families resulting from the use of the video system during hospitalization. Continuing medical education was another common theme. Five nurses felt that the video system should be in all the health aide and nursing stations, as well as in Thunder Bay and Winnipeg. Four felt that it was reassuring to be able to consult with a physician using a visual image.

Discussion

Provider acceptance of telemedicine is extremely difficult to measure. One obstacle is the limited number of providers associated with each project. Another is the high rate of staff turnover. Most telemedicine projects are conducted in remote regions where staffing is limited and living and working conditions are not ideal. In particular, before-and-after studies are nearly impossible to conduct.

Attitudinal data have been collected by many telemedicine researchers. Sanders et al⁶ surveyed the attitudes of the providers associated with the Dade County Jail telemedicine project. Provider attitudes were generally favorable, although the nurses were less satisfied than the physicians. Fuchs¹¹ surveyed the attitudes of the providers working on the Space Technology Applied to Rural Papago Advanced Health Care project in Arizona. The major problems cited by providers were the "poor" equipment reliability (even though it was down only 2.5 percent of the time) and the interruption of their already full work schedule to provide television consultations. In contrast to the results of Sanders et al, the non-physician providers were more positive toward the system than were the physicians.

O'Neill and colleagues¹³ surveyed seven telemedicine projects and found no significant attitudinal bias to the projects. They concluded that provider acceptance is usually related to the ease with which the telecommunications technology is integrated into the existing health care network and the ease of use of the technology.

Telemedicine systems are currently being considered by many health care planners. Consequently, the acceptance of telemedicine by the

providers who will eventually use these systems is a crucial issue.

The results of this survey are clear. The providers were positive toward the system. Furthermore, there appears to have been an improvement in their attitudes with experience in using the equipment. This latter conclusion is based on recall and is thus not so rigorous as one would like. However, that most of the providers said they became more positive toward the system over time is a strong argument that they, in fact, did so.

One of the problems faced by many researchers when evaluating the attitudes of telemedicine system providers is the limited sample size. In this study the sample of physicians was limited to four. With this small sample it appears that the physicians' attitudes were different from those of the nurses, especially when the physicians' comments were examined. Such a difference can be explained, perhaps, in the difference in the nature of their jobs and the training required for them. The nurses work independently in isolated communities with very little support. Their training, while excellent, is limited when compared with that of a physician. Thus, the nurses feel that telemedicine will provide them with needed backup in time of emergencies or difficult diagnoses. On the other hand, physicians have more extensive training and spend less than one half of their time in remote communities. They are capable of dealing with most complaints and do not feel the same need for backup that the nurses do. Hence, their need for teleconsultation is less significant than that of the nurses.

The slow-scan system has been in operation since late 1977. The research project ended in 1980, and at that point the Sioux Lookout Zone Hospital assumed control of the network and its associated operating expenses. This decision was not based on economic factors. Research indicated that the system was not cost effective.¹⁴ It was found that there were more transfers, not fewer, as a consequence of the presence of the video system. One possible explanation for this is that patients were receiving more careful attention than they were in the past, although this cannot be verified objectively.

Consequently, it appears that the system was retained for noneconomic reasons, likely related to the nonphysician providers' positive attitudes toward the system, a result of their need for medi-

cal backup from time to time, the security of knowing that this backup was available, and the educational opportunities provided by the system. At least in this project these reasons were sufficient to justify continued operation of the video network.

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References

1. Burket GE: Rural manpower. *J Kans Med Soc* 78: 475, 1977
2. Mason HR: Effectiveness of student aid programs tied to a service commitment. *J Med Educ* 46:575, 1971
3. Bass M, Copeman WJ: An Ontario solution to medically underserved areas: Evaluation of an ongoing program. *Can Med Assoc J* 113:403, 1975
4. Walcoff P, Nocerino J, MacArthur D, et al: An Investigation of Health Manpower Resources for Rural Primary Care Delivery, technical report MTR-6918. McLean, Va, The Mitre Corporation, 1975
5. Doermann A, MacArthur D, Walcoff P: Extending the Capabilities of Non-Physician Providers in Isolated Rural Areas: An Investigation of the Potential Impact of Telecommunication-Based Technology, technical report MTR-7063. McLean, Va, The Mitre Corporation, 1975
6. Sanders JH, Sasmor L, Natiello TA: An Evaluation of the Impact of Communications Technology and Improved Medical Protocol on Health Care Delivery in Penal Institutions. Coral Gables, Fla, University of Miami, 1974
7. Foote D, Parker E, Hudson H: Telemedicine in Alaska. The ATS-6 Satellite Biomedical Demonstration. Stanford, Calif, Institute for Communication Research, Stanford University, 1976
8. Higgins CA, Dunn EV, Conrath DW: Telemedicine in Northwestern Ontario. Madison, Wisc, Teleconferencing and Interactive Media, University of Wisconsin-Extension, 1980, p 195
9. Dunn EV, Conrath DW, Bloor WG, et al: An evaluation of four telecommunication systems for delivery of primary health care. *Health Serv Res* 12:19, 1977
10. Conrath DW, Dunn EV, Bloor WG, et al: A clinical evaluation of four alternative telemedicine systems. *Behav Sci* 22:12, 1977
11. Fuchs M: Provider attitudes toward STARPAHC: A telemedicine project on the Papago reservation. *Med Care* 17:59, 1979
12. Dunn EV, Conrath DW, Higgins CA, et al: Telemedicine links patients in Sioux Lookout with doctors in Toronto. *Can Med Assoc J* 122:484, 1980
13. O'Neill JJ, Nocerino JT, Walcoff P: Benefits and Problems of Seven Exploratory Telemedicine Projects, technical report MTR-6786. McLean, Va, The Mitre Corporation, 1975
14. Conrath DW, Dunn EV, Higgins CA: Evaluating Telecommunication Technology in Medicine. Dedham, Mass, Artech House, 1983