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A model for remote communities using store and forward telemedicine to reduce health care costs

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Objective: The Labrador Telemedicine Project looked at the effectiveness of a personal, computer-based store and forward telemedicine system between the remote community of Black Tickle in northern Canada and a small regional hospital in Goose Bay, Labrador.

Method: The nurse in the community captured video pictures, audio and text on all 43 cases involving 43 initial telemedicine consultations and 40 follow-up telemedicine consultations that occurred between Apr. 1, 1998, and Mar. 31, 1999. This information was stored in an electronic case file and sent to the hospital in Goose Bay, where the physicians reviewed the cases. Transmission was via microwave with a band width equivalent to an ordinary copper wire.

Principal results: This technology allowed the physician to make more informed decisions regarding patient management and the need for costly transfer. The nurse in the remote community felt more confident in treating the patient and provided a higher quality of care. Of 32 patients who responded to a patient satisfaction questionnaire, 84.4% believed that their care was much better, 15.6% that it made no difference and none believed that it was not as good as before. Fifty-one percent thought they had faster access to the physician. More patients were treated in the community, resulting in a reduced number of patients being transferred by air from the remote nursing station to the regional hospital. The cost of the system was $52 470. Assuming biennial replacement of the system equipment, the regional health authority will save $20 877 per year in patient transportation and the patients will save $8008 per year.

Conclusions: This pilot project demonstrates that a store and forward telemedicine application is clinically useful and is associated with a decrease in health care costs. The technology can be applied effectively in similar remote community settings.

Objectif : Dans le contexte du projet de télémédecine du Labrador, on a étudié l'efficacité d'un système de télémédecine personnel et informatisé de stockage et de transmission entre les communautés éloignées de Black Tickle, dans le Nord du Canada, et un petit hôpital régional situé à Goose Bay, au Labrador.

Méthode : L'infirmière de la communauté a stocké des enregistrements vidéos et sonores, ainsi que du texte, dans un dossier électronique qui a été envoyé à l'Hôpital de Goose Bay, où les médecins ont étudié les cas. La transmission s'est faite par micro-ondes au moyen d'une largeur de bande équivalant à celle d'un fil de cuivre ordinaire.

Principaux résultats : Cette technologie a permis aux médecins de prendre des décisions plus éclairées sur la prise en charge du patient et le besoin de transferts coûteux. L'infirmière de la communauté éloignée a senti qu'elle avait plus confiance dans le traitement du patient et a dispensé des soins de meilleure qualité. Sur les 32 patients qui ont répondu à un questionnaire au sujet de la satisfaction du client, 84,4 % pensaient avoir reçu des soins de bien meilleure qualité, 15,6 % croyaient que cela n'avait fait aucune différence et aucun n'était d'avis que les soins n'étaient pas aussi bons qu'auparavant. Cinquante et un pour cent des patients pensaient avoir accès plus rapidement au médecin. Plus de patients ont été traités dans la communauté, ce qui a réduit le nombre de patients transférés par avion des postes de soins infirmiers éloignés à l'hôpital régional. Le système a coûté 52 470 $. Si l'on suppose que le matériel du système sera remplacé aux deux ans, l'administration régionale de la santé économisera 20 877 $ par année en frais de transport de patients et les patients éviteront des dépenses de 8008 $ par année.

Conclusions : Ce projet pilote démontre que l'application de stockage et de transmission de la télémédecine est utile sur le plan clinique et entraîne une diminution des coûts des soins de santé. La technologie peut être appliquée efficacement dans le contexte de communautés éloignées semblables.

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As in many parts of Canada, the population of Newfoundland and Labrador is scattered over a large area. This is particularly true of Labrador where the population of 30 000 is dispersed over an area the size of the United Kingdom. The provision of health services under such circumstances is challenging.

Access to a full range of health care services is more limited in sparsely populated rural communities than in densely populated urban settings. Rural health practitioners experience professional isolation. Telehealth addresses both patient access and professional isolation by enhancing the clinical, informational and educational support available in rural communities. This technology has the potential to deliver effective, efficient, appropriate health care for people in rural areas.1,2

Modern technologies are often available only in urban centres and in developed countries. The development of telehealth, while challenging, creates opportunities for improving the health of rural communities.3 Advances in information technology and telehealth have made accessibility to health service more feasible in rural communities.4,5 Telehealth applications appear to be quite well accepted by patients and health providers.6,7 Although telehealth is now considered necessary,8 there is little evidence of its cost effectiveness.9–11

The Labrador Telemedicine Project was designed to evaluate the effectiveness of a relatively inexpensive store and forward telemedicine system to link a remote Labrador nursing station in Black Tickle to a regional hospital in Goose Bay using analogue telephone lines. Its objectives were to determine if the use of the telemedicine system has any effect on

- the diagnosis and treatment of remote patients;
- patient transfer;
- nurses' confidence and education; and
- if the quality of the medical information transmitted over dial-up lines is acceptable;
- if the nurse, physician and patient are satisfied with the technology; and
- to conduct a cost analysis.

The rationale for this pilot project was two-fold.

1. Nurses in remote areas have indicated they want more assistance in making a diagnosis, selecting treatment and deciding whether or not patients need to be transferred.

2. With a limited road network, travel in Labrador is usually by plane. It is expensive, difficult and often weather dependent. When patients in Black Tickle require medical attention that cannot be provided by the local nurse, the only option is to travel to Goose Bay. This is time-consuming and expensive for the patient as well as for the health care payer.

This study assessed a telemedicine system that offers text, audio and image transmission but does not assess the relative merits of each component individually. The study does not take into account the dynamics of nurse–patient–physician relationships and their impact on the utilization of, and response to, the telemedicine system. The cost analysis is limited to the 1 year duration of the study. Longer term monitoring would be ideal.

Methods

Equipment

VisiTran-MD, a PC-based store and forward telemedicine system with a processing speed of 266 MHz and 128 megabytes of RAM, was chosen. This system was developed by MedVision, Inc., Minneapolis. MedVision, Inc., has since been acquired by Informed Care Solutions, a division of Informed.com, Charlottesville, Va. (Note: Informed Care Solutions support this platform but have ceased further development of it in favour of other software solutions.) VisiTran-MD was a medical case creation software package that facilitated the capture of video pictures, audio and text. Peripheral devices used were an Andries Tek general examination camera to capture images of all external parts of the body and internal parts such as the cervix and pharynx and an Andries Tek otoscope to view the external auditory canal and ear drums. (Both these devices are now the property of American Medical Development, Lowell, Mass., and have been renamed "Scalar general exam camera" and "AMD-300 w/Otoscope," respectively.)

Information was stored in an electronic case file, and the file was sent by a dedicated telephone line, equivalent to the copper wire, from the telemedicine system in Black Tickle to the telemedicine system in Goose Bay. There the case was reviewed by a physician. The link was with a 56 kbps modem with an average speed of less than 14 kbps.

Study population

The community of Black Tickle (population: 210) was chosen as a representative rural community in northern Canada where access is usually by air. Travel by snowmobile in winter and boat in summer is possible but is impractical for health delivery. The provincial government subsidizes most of the cost of air travel for medical reasons. Black Tickle is served by a resident primary care nurse and a visiting physician, who travels to the community once every 5 to 6 weeks for a week at a time. There are approximately 3000 patient visits to the clinic annually, with an average of 90 physician telephone consultations per year.

Study design

The study year was from Apr. 1, 1998, to Mar. 31, 1999. Before the study began Black Tickle's primary care nurse and the hospital physicians were trained in the use of the telemedicine equipment. During the study, the primary care nurse in the Black Tickle clinic used the telemedicine system for any cases that required physician consultation. Questionnaires were developed to assess how patients, primary care nurses and consulting physicians felt about using the telemedicine system. The patient and nurse questionnaires were administered immediately

after the telemedicine consultation. The 2 physicians involved in the study completed their questionnaires at the end of the study period. A prospective log was kept, with particulars relating to all cases sent on the telemedicine system and all cases sent out for consultation to the regional hospital. Costs for scheduled and emergency transportation of patients were determined using current costs for patients and for the regional health authority, the Health Labrador Corporation.

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Results

During the study period there were 83 cases, consisting of 43 initial consultations and 40 follow-up consultations, where the telemedicine system was used. The telephone was used only to alert the consulting physicians of urgent need for consultations. There were 95 telephone consultations in the previous year. There were 3 emergency medical evacuations and 85 scheduled out referrals during the study year compared with 14 emergency medical evacuations and 113 scheduled out referrals in the preceding year, a significant decrease (chi squared = 4.1375, $p < 0.05$). The number of scheduled and emergent medical evacuations during the year before the telemedicine was introduced was the same as the average for the previous 5 years, suggesting that it is a representative year to use for comparison. During the fiscal year of 1998/99, when telemedicine was introduced, the cost to the regional health authority for emergency and scheduled transportation of patients was reduced from $88 208 to $38 961, a reduction in cost of $49 247 or 56%. Patients in the community saw a reduction of $8008 or 25% of their annual expenditure for health care transportation, from $32 318 in the year before telemedicine was introduced to $24 310 per year with telemedicine (Table 1).

The capital cost of the system and the cost for 1 year of a dedicated analogue telephone line used in the referring community and the referral hospital was $52 740 (Table 2). In 1 year, Health Labrador Corporation and patient savings in transportation alone have more than paid for the capital and operating cost. Assuming the system will have to be completely replaced in 2 years, the system will save Health Labrador Corporation $20 877 per year (reduction of expenditures over 2 years [$49 247 × 2] minus online charges [$4000 × 2] minus equipment cost [$48 740] = $41 754 divided by 2 years). The cost of the system is decreasing. Similar software and hardware can now be purchased at one-half of the initial cost. To date, the cost of peripheral devices has not changed.

Patient feedback

Patients in general liked the system. Forty-three patients were given questionnaires, and 32 (74%) responded. When asked to describe the advantages of telemedicine 22 respondents (or 69%) most commonly listed faster access to a physician. All of the respondents were comfortable with the

technology. Twenty-seven respondents (or 84%) thought their health care was better and 5 (or 16%) felt that it made no difference to their care. None thought that their care was not as good.

Follow-up of the 11 non-respondents revealed that they were unable to complete the questionnaire due to limited literacy skills. Informal discussion with these patients provided feedback comparable to that obtained from the respondents.

Primary care nurse's feedback

The solo primary care nurse's experience with the telemedicine system was very positive. In 91% (or 39) of the 43 cases the nurse felt strongly that the feedback allowed for better care of the patient. The nurse felt comfortable using the system in all cases and reported it was easy to use in 35 of the 43 cases or 81% of the time. In 49% or 21 cases, the nurse gained clinical knowledge from the interaction while using the system.

Physicians' feedback

The 2 doctors involved in the study felt that unlike a telephone consultation, the telemedicine system permits the transmission of visual images, thereby improving physician confidence in the severity of the condition and the diagnosis. The store and forward system allowed for cases to be stored and seen at a convenient time. Not only was less time required with telemedicine consultation, but the physicians also had the opportunity to provide a more considered response than was possible in a telephone consultation. The system encouraged a more concise and organized description and assessment in both audio and written format. There was less need to describe the condition with visual images. Urgent cases could still be addressed by phoning the physician to request that the case be viewed immediately.

Changes in pattern of distance consultation

The telemedicine system was used in 43 cases. Of those cases 13 (or 30%) relied on telemedicine to confirm a treatment plan, 12 (or 28%) used it to confirm a diagnosis, 8 (or 19%) to make a new diagnosis, 4 (or 9%) to develop a new treatment plan, 2 (or 5%) to follow up on wound healing, 1 (or 2%) to modify an existing treatment plan, 1 (or 2%) to arrange transfer and 2 (or 5%) for other reasons.

During the study period, distance consultation was used to confirm a diagnosis or to make a new diagnosis more than during the pre-telemedicine era. This change in the pattern of distance consultation is reflected in Fig. 1. The nurse using the telemedicine system felt that in 56% (n = 24) of the 43 cases, it would have been impossible to obtain the information needed to manage the patients through a telephone consultation.

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Discussion

The telemedicine system used in this project comprises medium-cost computer hardware, high-end store and forward telemedicine software and 2 high-end peripheral devices. The use of an electronic stethoscope was investigated but not introduced because of cost. High-end peripheral devices were chosen to provide high-quality images.

A dedicated phone line was installed at each of the 2 sites for the study. This was done mainly for convenience so that the line would be free for transmission. It also helped to determine usage costs accurately. With low traffic volume a dedicated line is not a necessity. Each image takes only about 30 seconds to transmit over the analogue telephone line. Video and audio files are much larger and require a longer time for transmission. In our project, no cases took longer than 20 minutes to transmit. Users of the system learn to capture only relevant video clips and to be concise in voice recording. It is possible to program transmission to occur at certain times of low traffic volume, but this was not done in this project because there was a dedicated phone line. The dedicated phone line is being maintained following completion of the research project.

A store and forward technology was convenient for the referring nurse and the consulting physicians. There was no need for the nurse to wait while the usually busy physician was paged. It saved time for the physician as cases were ready in the folder for review with entry of the password and the clicking of a mouse. The reply was either entered on the key board, phoned or returned as an audio file. If cases needed to be reviewed immediately the physician was contacted by phone to go to the telemedicine system and the files were available for review by the time the physician entered the system. Where there is a high volume of cases, live video teleconsultation may be advantageous, provided the physician can view several cases in a single session. Live transmission is, however, costly, requires more band width and may not be cost-effective for low case loads associated with small communities. The use of live video in rural settings requires further study.

With an increasing number of cases and their follow up, it would be useful if the software could permit follow-up transmissions for an individual patient to be linked to the original electronic patient file. It would be easier to assess progress if multiple windows are available for comparing visual images of different consultations on the same patient.

The users (patients, referring nurse and consulting physicians) were satisfied with the system. No patients disliked using the system. Most of the patients were comfortable with the system and felt that it improved their health care. The referring nurse was more comfortable working as a solo nurse with the support afforded by the physician through the telemedicine system. The physicians found it easier to assess the cases and to provide advice to the nurse and through the nurse to the patients. Patients and nurses felt there was increased and more effective access to physician services. The low literacy level among patients and consequent high non-response rate (26%) to

the patient questionnaire highlights the importance of pre-testing the tool used to assess patient satisfaction.

In a period of 1 year, Health Labrador Corporation recovered 93% of the capital and operating costs of the telemedicine system through cost savings in patient transportation. Other potential savings in areas such as inpatient stays and emergency visits were not calculated.

The telemedicine system provided the referring nurse with case-based, continuing education. The professional development of the nurse and the professional relationship between the nurse and physician may have contributed to the decline in referral out of the community.

Although the nature of patient visits to the clinic during the study year was not compared with that of the previous year, the burden of illness in the community has not changed in the past 6 years. There was no decline in population, nor was there a change in nurse or physician staffing to explain the significant decline in transportation of patients out of the community during the study period. It is recognized that nurse–patient–physician relationships were not assessed and may have influenced this outcome.

Conclusions

The store and forward telemedicine system is a practical way to conduct medical consultations to small, isolated communities with a low volume of health care service usage. It was associated with a significant reduction during the study period in the need to transport patients out of the community for physician services. In our setting in northern Canada, the system has resulted in a 56% reduction in government costs and a 25% reduction in patient costs for medical transportation. These results suggest this is a cost-effective model for this region and may be applicable for other rural communities with similar settings.

Competing interests: None declared.

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