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Telehomecare: Quality, Perception, Satisfaction

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ABSTRACT

The aim of this study was to demonstrate that telehomecare linking homebound patients with their home health-care nurses over the plain old telephone system (POTS) provides high-quality, clinically useful, and patient satisfactory interactions. Congestive heart failure, chronic obstructive pulmonary disease, and chronic wound-care patients receiving skilled home nursing care were randomized into control (standard home health care, HHC) and two intervention (standard care plus video conferencing/Internet access; the above plus physiological monitoring) groups. Virtual visits (VVs), consisting of two-way audio and video interactions between the central site HHC nurse and the subject at home, were compared for technical quality and clinical usefulness by the HHC nurses who performed the VVs. Subject perception of telehomecare and satisfaction with their HHC were assessed over the course of the project. There were a total of 567 virtual and 1,057 actual visits conducted for the 53 subjects completing the study. The technical quality of VVs were rated at 94.7%. They were considered to be as useful as actual visits in 90.7% of cases. Subject telehomecare perception increased after experiencing the process. All subjects were satisfied with their HHC; satisfaction increased with an increasing level of telehomecare intervention. Subjects receiving physiological monitoring and video conferencing/Internet access in addition to standard care were most satisfied with their care. VVs can be conducted over POTS. Patients can use telehomecare with moderate levels of training. These programs can provide timely and quality home health nursing care with VVs augmenting traditional home visits.

INTRODUCTION

TELEMEDICINE USES TELECOMMUNICATIONS and information technology to enable or support health-care delivery services. These technologies have been used within and across health institutions and between health-care professionals for such services as remote evaluation of radiological images and distribution of laboratory results, or consultations with clinical experts.[1] The more recent availability of lower-cost telecommunications systems and physiological monitoring devices designed for patient self-measurements have made it possible to bring the advantages of telemedicine directly into the patient's home, thereby linking patients at home with their care providers at a clinical center or home health-care (HHC)

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agency. Typically, these applications involve real-time transmission of voice, video, and data or some combination of the three. Home-based telemedicine introduces new technological, societal, educational, and financial questions that must be addressed before it can become more widely used. This telehomecare project was designed to address many of these questions, and to demonstrate the feasibility of this application from both a technical and human-factors perspective while delivering cost-effective quality care to patients receiving skilled nursing care at home.[2]

The number of HHC visits and the cost of HHC have been increasing. The National Association of Home Care has estimated expenditures for 2001 to be $41.3 billion, incurred while serving approximately 7.6 million individuals.[3] Professional health services such as clinical and medication monitoring and home-care education are generally delivered by skilled nursing personnel traveling to the patient's home. Patients and their families often need additional help with medication dosing, symptom management, anxiety with daily cares, support for caregivers, and assessing the need for a physician visit. When such home services are not available, the patient may have to travel to the nearest clinic site to obtain needed clinical consultation services. For rural and under-served urban patients travel and access problems can pose severe limitations on their ability to receive timely quality care. The technology used in telehome care could provide an alternative, cost-effective method to deliver these services.

Self-monitoring programs using paper-based diaries for patients with asthma or cystic fibrosis were reported in the literature more than 15 years ago.[4–6] Patients recorded symptoms and minimal physiological measurements (which were limited by the availability of easy-to-use, clinically relevant, and inexpensive monitoring devices) on either a regular schedule or when problems occurred. They mailed the diary reports to their health-care provider for interpretation and possible action. The use of the standard telephone system to transmit clinical information from the patient to the caregiver provided the initial applications of telemedicine, which depended on the patient's response to a predetermined list of questions or the monitoring of physiological variables with specially designed devices.[7–9] In some applications, patients were instructed to contact their caregiver only if measurements fell outside predetermined values, placing the entire burden of detection on the patient, while in other applications the physiological measurements were stored in the instrument and downloaded over the telephone to the provider site, where they were reviewed to identify possible deteriorating conditions.[10,11]

Expanding telemedicine applications from data and voice transmission to videoconferencing allows the caregiver to observe the patient during a virtual visit (VV), recommend treatment changes, and monitor responses to these changes without the need for the patient to travel to the care center or for the caregiver (e.g., home health nurse) to visit the patient. A VV consists of two-way audio and video interactions between the central site HHC nurse and the patient at home. The training of patients in particular home care activities such as spirometry for asthmatic or chronic obstructive pulmonary disease patients or wound-dressing procedures for diabetic patients needing chronic wound care can be addressed using the video components of telemedicine. This may be particularly beneficial for patients living in rural areas, those needing frequent observation, and those often too ill to travel to the care center for routine observation. While these may be obvious applications for telemedicine technology, there are several challenges that must be addressed before there is widespread diffusion of this technology into the health-care system. These challenges include the demonstration that telemedicine from home is both clinically and cost effective, that quality virtual visits can be achieved regularly with little patient effort, and that patients and caregivers are satisfied with virtual visits replacing some traditional face-to-face encounters. Public policy issues of reimbursement, data privacy, and liability all remain to be clarified before this technology will be widely adopted for direct patient care.[12] The results of randomized clinical trials which affirm the effectiveness and acceptability of telemedicine from home should play a major role in shaping these policy decisions.

MATERIALS AND METHODS

The telehome care project was a randomized, controlled trial funded by the Technology Opportunities Program of the U.S. Department of Commerce to assess the benefits of using low-cost, standards-based telecommunications and monitoring technologies for homebound patients needing skilled HHC. The collaborative project was between the University of Minnesota, four local industry partners, and four clinical partners representing both urban and rural Minnesota. The industry partners providing equipment and/or services for the project were QRS Diagnostic, LLC (spirometers), Nonin, Inc (pulse oximeters), CareFacts™ Information Systems, Inc. (home health-care information systems), and Onvoy, Inc. (Internet services). The clinical partners were Fairview Health System representing an urban HHC provider, and Tri-County Hospital–Wadena, Lakewood Health System–Staples, and Cuyuna Regional Medical System–Crosby representing rural HHC providers. Telehomecare focused on congestive heart failure, chronic obstructive pulmonary disease, and chronic wound-care patients, three clinical areas that employ significant HHC resources.

Patients were randomly assigned to one of three groups, stratified by medical problem. Control groups for all three medical problems received standard HHC as determined by their underlying condition. Subjects in the video group received HHC plus two supplemental VVs per week and Internet access. Subjects in the monitoring group received all of the above plus home-based physiologic monitoring and an electronic diary. Sixty-eight subjects were recruited among the four sites to participate in the study and 53 subjects completed the study. To be included in the study, subjects had to be eligible for skilled nursing home care with a primary or secondary diagnosis of one of the clinical areas of interest. Subjects or a supportive care partner had to be physically and cognitively able to use the equipment within a technically functional home environment, i.e., one with sufficient space for the equipment to be set up and remain in one place, close proximity of a telephone line to an available television, adequate lighting, and manageable clutter. The discharge criteria were termination from home care, loss of eligibility for home care, or the need to move to a higher level of care such as a nursing home or hospital. There were 19 (9F, 10M), 14 (8F, 6M), and 20 (9F, 11M) subjects in the control, video/Internet, and video/Internet/monitoring groups, respectively. All subjects provided informed written consent. The average age of all subjects was 74.3 years (with an age range of 50–90 years). Age distributions in each group were similar. The average age of the 15 subjects who did not complete the study was 77.8 (with age range of 60–96). Subjects dropped out of the study for various reasons, including illness, concerns with handling the equipment, inadequate telephone service, and relocation.

The system in the subject's home consisted of a set-top box (ViaTV VC55, 8×8 Inc, Santa Cruz, CA) connected to a television set and telephone line. A lightweight, variable focus eyeball camera (VC73105T, Philips Electronics, NY) was placed on the box. It had a 6-foot tether for easy positioning so that the camera, and not the subject, could be moved to transmit real-time pictures of wounds, swollen ankles, etc. An easy-to-use focusing adjustment and freeze-frame video mode made it possible to transmit good-quality images for evaluation. A similar set-top box (ViaTV VC105 with built-in camera, 8×8 Inc, Santa Cruz, CA) was used at each HHC telemedicine site. HHC nurses initiated virtual visits by telephoning the subject; the subject simply answered the call and turned on the videoconferencing system. The nurse controlled audio and video adjustments at both sites. The set-top box in the subject's home had Internet access. Service accounts were set up for all video and monitoring subjects by an Internet service provider. A toll-free access number was provided to simplify the process. Subjects also had access to a simple Web-based messaging system that provided the opportunity to communicate with the nursing personnel at their home care agency. Customized Web pages were designed to accommodate some of the special needs of the typical elderly subjects by using large, easy-to-read text, simple colors and well-marked and explained links to other pages of interest.[13]

Physiological monitoring was accomplished using a home spirometer (SpiroCard®, QRS Di-

agnostic LLC, Minneapolis MN), a clip-on pulse oximeter (Onyx, Nonin Inc, Minneapolis), automatic blood pressure cuff, and a daily electronic diary of measurements and symptoms submitted via the Internet. Specific monitoring variables were selected for each of the three clinical conditions. A customized home page, created for each noncontrol subject, using an automated system interface, allowed access to selected disease information and, for those in the monitoring group, the electronic diary questions. Subjects in the monitoring group were asked to monitor their symptoms, diet, exercise, and medications and report them daily using the electronic diary. Questions not answered were highlighted and redisplayed. Any additional information that the subject wished to communicate to the nurse (e.g., questions, remarks) was sent via an electronic message board. Weekly reports showing responses over the past 2 weeks were automatically e-mailed to the designated nurse. In addition, whenever the data were outside of values preset by the provider, a "red flag" was triggered and a summary report was immediately generated with a warning message to the nurse, who then contacted the subject and determined if a physician should be consulted.

All standard medical charting data for telehome care patients were recorded in the CareFacts™ Clinical Information System, designed for HHC utilization. CareFacts™ uses the Omaha System as a standardized language to structure each assessment—to identify problems (diagnoses), select interventions for care planning, and to rate patient outcomes.

Outcome measures for this study were mortality and morbidity, time to transfer to a higher level of care (e.g., hospitalization or long-term care facility), subject perception of telemedicine, subject satisfaction, quality and clinical usefulness of virtual visits, subject utilization of services, and cost for both subjects and service providers. As of this writing, data on evaluation of clinical effectiveness, cost and resource utilization are not yet available. Nurses reported on the technical quality and utility of each VV using standardized evaluation forms.[14] The Telemedicine Perception Questionnaire (TMPQ), developed for this study, was administered at the start of the study and after 1 month to all subjects.[15] The Home Care Client Satisfaction Instrument (HCCSI) was completed by telephone interview of all subjects after their discharge from HHC.[16] This instrument was pretested and validated. Forty-seven of the 53 subjects were interviewed by telephone after they concluded the study or were discharged from HHC. One investigator conducted all the interviews.

RESULTS

The 53 subjects who completed the study had a total of 567 virtual visits (276 for the video group and 291 for the monitoring group) and 1,057 actual home visits (258 for video group, 379 for the monitoring group, and 420 for the control group) by HHC nurses. HHC nurses conducting the VVs encountered few technical problems and found them almost always useful. In 443 VVs for which there were completed technical quality reporting forms, the average technical quality rating was 94.7% and the HHC nurses responded that the VVs were as useful as actual visits in 90.7% of cases. These VV reports represented all subjects in the video and video/monitoring groups.

In a preliminary review of subject perception of telehome care, Demiris *et al*. administered the perception questionnaire to 28 subjects (11 in the control group, 17 in the video/monitoring groups) at their entry into the study (pre-test) and 4 weeks later or at exit from home care (post-test), whichever occurred sooner.[17] Individual scores can range from 17 to 85, with higher scores indicating a more positive perception of telehome care. There were no statistically significant differences in age, gender, or clinical diagnosis (reason for home care) between the groups. The pre-test scores did not show a statistically significant difference between the groups. The pre- and post-test scores for the control group were 58.1 and 57.9, respectively, indicating no change in perception among subjects who did not experience it. The post-test score for the video/monitoring group was significantly higher than the pre-test score (57.8 vs. 63.9, respectively, $p < 0.0001$), indicating that subjects developed a more positive perception of telehome care after experiencing

TABLE 1. HCCSI QUESTIONS

2.	Attention to concerns
3.	Dependability of staff
4.	Respect shown by staff
5.	Knowledge of health problems
6.	Choices about care
7.	Feeling safe
8.	Know contact person
9.	Ability to meet needs
10.	Response to concerns
11.	Scheduling
12.	Consistency in staffing

From Westra *et al*.[16]

it for several weeks. After participation subjects expressed more positive views regarding the nurse's understanding of their individual medical problems over the television (i.e., by video conference), and ease of use of the equipment as well as its reliability. Their perception of time savings for the nurse improved, but not so for their own time.

The client satisfaction questionnaire consisted of 12 questions (see Table 1) related to specific aspects of home care, and three global measures of satisfaction (items 13–15, not included in Table 1). All patients were satisfied with their care, but satisfaction ratings significantly increased for virtual visit subjects (see Fig. 1).[18] The greatest increase in satisfaction involved attention to concerns, feeling safe, ability to meet needs, and flexibility in scheduling. Generally, satisfaction increased with the level of telehome care, from control, to video, to monitoring groups.

DISCUSSION

Elderly patients receiving skilled nursing HHC can successfully use video conferencing and physiological monitoring equipment to participate in VVs with their nurses at the HHC agency. This was accomplished by transmitting audio, video, and data signals over regular voice-grade telephone lines available in most homes. Equipment was easily installed by either the nurse or technician after brief training sessions. Patient attitude, vision, and motor control were important determinants of success. Knowledge about telemedicine, enthusiasm, and actions of the HHC nursing staff were equally important in achieving success. Modifications in equipment, software interfaces, and information presentation mode were necessary to adapt to client needs Yet, telehome care was not acceptable for every patient. Several eligible candidates refused to participate because of

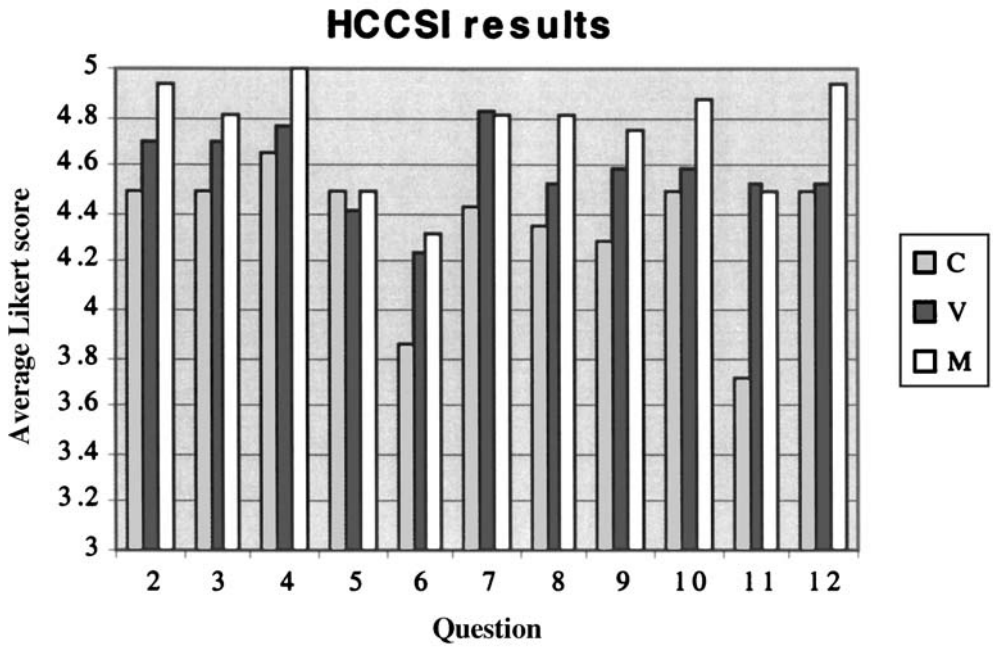

FIG. 1. Results of the HCCSI for participants in the Telehomecare project. Questions 1 and 13–15 were omitted because they do not relate to the telemedicine aspects of the HHC process. From Veen M, Finkelstein SM, Speedie SM, Lundgren JM. Patient satisfaction with telehomecare. *Proc Joint EMBS/BMES Conf.* 2002; 2:1845–1846, and reprinted with permission from IEEE, © 2002 IEEE.

concern over the equipment. Others who expressed similar concerns but were willing to try telehome care were able to take part in virtual visits without any problems. The pre- and posttest results support this observation. Those who actually experienced the system had more positive views than the control group. Thus it will be important to get potential clients engaged with the new systems to overcome their reluctance to "try something new."

These findings are consistent with other studies. For instance, a recent review of patient satisfaction with telemedicine reported that most patients were satisfied with the improved accessibility to specialist care, decreased travel, and reduced waiting times, but were somewhat concerned about communication with their providers.[19] Whereas this review has dealt primarily with teleconsultations, there were also a number of HHC/home nursing studies included. Johnston *et al*. reported no differences in patient satisfaction between in-home actual visits and video and physiological monitoring.[20] Subjects in this study were newly referred patients diagnosed with congestive heart failure, chronic obstructive pulmonary disease, cerebral vascular accidents, cancer, diabetes, anxiety, and chronic wound care. These reports agree with the satisfaction results found in the current telehomecare study in which both control and intervention groups were satisfied with HHC, but the intervention group became more satisfied with their care with greater level of intervention (video vs. video and monitoring).

The results from the Johnston study showed no differences in quality indicators, patient satisfaction, or resource use between study and control subjects.[20] The authors suggested that telemedicine has the potential for cost savings when used as a substitute for in-person visits. In a recent report on a telehome care application with diabetic homebound subjects, Dansky *et al*. reported that telehome care produced substantial cost savings despite the additional expenses associated with its delivery, as well as, greater financial benefits as the duration of the care increased.[21]

The clinical and cost effectiveness of this telemedicine application cannot be determined until the full study analysis is completed. However, the generally positive attitude of the technology users is a critically important indicator of future success. Nurse assessments on virtual visit quality and clinical usefulness, coupled with patient positive perception of telehomecare as an adjunct to their traditional HHC and their high level of satisfaction with their home care when it included video and monitoring, indicate the potential of this technology to make an impact on how home care will be delivered in the future. Virtual visits could provide an effective and efficient adjunct to traditional HHC within the new HHC prospective payment system guidelines. Recent policy changes on the part of payers is another positive sign of future adoption of this technology in home care, including reimbursement on a national level for some forms of home monitoring (*e.g.,* home spirometry) and on a local county level for telehomecare. Lessons learned from this study can be applied to the development and implementation of telehomecare programs for other HHC applications, rehabilitative therapy services, and the management of chronic disease.

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REFERENCES

1. Perednia DA, Allen A. Telemedicine technology and clinical applications. *J Am Med Assn* **1995;**273:483–488.
2. Finkelstein SM, Speedie SM, Lundgren JM, Demiris G, Ideker M. Telehomecare: virtual visits from the patient home. *Home HlthCare Mgt Practice* **2001;**13: 219–229.
3. National Association Home Care. Basic statistics about home care. http://www.nahc.org/Consumer/hcstats.html, **2002.**
4. Tippett LO, Zeleznick LD, Knowles WE. The use of computer-based diaries for the assessment of subject symptomology. *Methods Informat Med* **1975;**14:62–68.
5. Kurata JH, Glovsky MM, Newcomb RL, Easton JG. A

multi-factorial study of patients with asthma. Part 1: data collection and rapid feedback. *Ann Allergy* **1976;** 37:231–245.
6. Finkelstein SM, Budd JR, Warwick WJ, Kujawa SJ, *et al*. Feasibility and compliance studies of a home measurement monitoring program for cystic fibrosis. *J Chron Dis* **1986;**39:195–205.
7. Zuspan FP, Rayburn WF. Blood pressure self-monitoring during pregnancy: practical considerations. *Am J Obstet Gynecol* **1991;**164:2–6.
8. Otulana BA, Higenbottam T, Ferrari L, Scott J, *et al*. The use of home spirometry in detecting acute lung rejection and infection following heart-lung transplantation. *Chest* **1990;**97:353–357.
9. Bjortuft O, Johansen B, Boe J, Foerster A, *et al*. Daily home spirometry facilitates early detection of rejection in single lung transplant recipients with emphysema. *Eur Resp J* **1993;**6:705–708.
10. Finkelstein SM, Snyder M, Edin Stibbe C, Lindgren B, Sabati N, Killoran T, Hertz MI. Staging of bronchiolitis obliterans syndrome using home spirometry. *Chest* **1999;**116:120–126.
11. Finkelstein J, Cabrera MR, Hripcsak G. Internet-based home asthma telemonitoring: can patients handle the technology? *Chest* **2000;**117:148–155.
12. Puskin DS, Sanders JH. Telemedicine infrastructure development. *J Med Syst* **1995;**19:125–129.
13. Demiris G, Finkelstein SM, Speedie SS. Considerations for the design of a web-based clinical monitoring and educational system for elderly patients. *JAMIA* **2001;**8:468–472.
14. Demiris G, Speedie SS, Finkelstein SM. The nature of communication in virtual home care visits. *Proc AMIA Symp* **2001;**135–138.
15. Demiris G, Speedie S, Finkelstein S. A questionnaire for the assessment of patients' impressions of the risks and benefits of home telecare. *J Telemed Telecare* **2000;** 6:278–284.
16. Westra BL, Cullen L, Brody D, Jump P, Gearon L, Milad E. Development of the home care client satisfaction instrument. *Publ Health Nurse* **1995;**12:393–399.
17. Demiris G, Speedie SM, Finkelstein S. Changes of patients' perceptions of Telehomecare. *Telemed J E Health* **2001;**7:241–248.
18. Veen M, Finkelstein SM, Speedie SM, Lundgren JM. Patient satisfaction with Telehomecare. *Proc Joint EMBS/BMES Conf* **2002;**2:1845–1846.
19. Mair F, Whitten P. Systematic review of studies of patient satisfaction with telemedicine. *Br Med J* **2000;** 1517–1520.
20. Johnston B, Wheeler L, Deuser J, Sousa KH. Outcomes of the Kaiser Permanente Tele-Home health research project. *Arch Fam Med* **2000;**9:40–45.
21. Dansky KH, Palmer L, Shea D, Bowles KH. Cost analysis of telehomecare. *Telemed J e-Health* **2001;**7:225–232.

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