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# Cost Analysis of Telehomecare

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## ABSTRACT

**The demand for home health care has skyrocketed in recent years. The aging population and the push for more efficient delivery of hospital services have fueled this growing demand. However, health care financing reforms have constrained the industry's growth. Home health agencies struggle to deliver high-quality services while staying within the financial limitations imposed by reimbursement changes. Telehomecare is one way to provide cost-effective care in the current environment. Personal computers and video equipment can transmit data over ordinary telephone lines and allow home health providers to monitor patients and provide care at a much lower cost than earlier technologies that required wider bandwidth telephone lines and more complex equipment. But can telehomecare yield cost-savings for home health agencies? This article addresses the costs associated with a telehomecare intervention in a large, urban, home health agency. The purpose of the study was two-fold: (1) to test the effects of telehomecare on clinical outcomes, and (2) to estimate the financial costs associated with providing telehomecare services. Our results show that, while telehomecare imposes additional expenses for care delivery, it contributes substantial savings without compromising quality. Additionally, we found that the financial benefit increases exponentially as the duration of the patient care episode increases.**

## INTRODUCTION

TELEMEDICINE[1] has been part of the U.S. health care system for several decades. Improved technologies and the current emphasis on cost containment in health care have pushed telemedicine to the forefront of health care delivery. Traditionally the domain of physicians and the academic medical community, telemedicine has recently moved into nontraditional settings such as home health care.

Telemedicine applications in home health care are a relatively new phenomenon. Using personal computers and video equipment that transmit data over ordinary telephone lines, home health providers are now able to monitor patients and provide care at a much lower cost than earlier technologies that required wider bandwidth telephone lines and more complex equipment. In addition to observing and interacting with the patient, a home health nurse can use medical devices attached to the patient's computer terminal station to assess clinical problems and health status. For example, an electronic stethoscope allows a nurse to listen to the patient's heart and lungs. A cuff and sphygmomanometer can provide measurement and transmission of body temperature, weight,

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blood glucose levels, and pulse oximetry with the newest generation of models.

In addition to monitoring patients with chronic diseases such as congestive heart failure and diabetes, telehomecare has the potential to provide care to high-risk patients typically cared for in hospitals. Telehomecare can also aid disabled persons, connect socially isolated individuals to their care providers, and enhance caregivers' effectiveness. Several practical capabilities of telehomecare are just beginning to emerge.

The evolution of telehomecare will help meet a growing demand for home health services. An aging population has fueled the push for more efficient delivery of services and the number of home health agencies. According to the National Association for Home Care, over 20,000 certified providers delivered home care services to approximately eight million individuals in 1999.[2] In addition, the average number of home health visits per user rose between 1995 to 2000, and is expected to increase from 65 to 82 over the next 5 years.[3]

Home health agencies must meet increased demand for services while meeting the financial limitations imposed by recent reimbursement changes. These changes in traditional cost reimbursement methodologies have provided several iterations of cost reductions for home health agencies. The 1997 Balanced Budget Act, implemented in October, 1999, further altered the financing of home care by mandating an interim payment system for Medicare home care beneficiaries. Additionally, home health agencies are now reimbursed at levels 2% lower than 1993–1994 levels.[4] These systematic reductions have challenged home health agencies abilities to meet patients' needs in traditional ways and forced them to explore new options to survive.

### *Telehomecare: a solution that embraces access, quality and cost*

We propose that telehomecare has the potential to provide cost-effective care under current reimbursement constraints. However, few studies have examined telehomecare from an economic perspective. Anecdotal reports of telehomecare suggest that it is a viable and cost-effective method of delivering health care services in the home.[5–7] One early study estimated telehomecare costs at $300–$400 a month for each patient. By comparison, traditional home visits by a registered nurse cost at least $500 a month for just three visits a week.[8]

Of those studies that have focused on costs of telehomecare, few have linked costs with clinical outcomes.[5,9] Moreover, most studies that have attempted to link patient outcomes with the use of telehomecare consisted of very small sample sizes and lacked the statistical power to make reliable conclusions. The most comprehensive study to date is the Kaiser-Permanente (KP) Tele-Home Health Research Project, a quasi-experimental study conducted in Sacramento California from May, 1996, to October, 1997.[10] In the KP study, home health patients (n = 212) were randomly assigned to an intervention or control group. Both groups received routine home health care, but the intervention group received video visits in addition to home visits. Results showed no differences in quality indicators. The average direct cost for home health services was $1830 for patients in the intervention group and $1167 for the control group patients. However, after consideration of the costs of rehospitalization, there was a cost savings of $63.00 per patient in the intervention group. This study was the first to demonstrate that telehomecare is capable of maintaining quality of care while producing cost savings.

The expansion of services will yield many lessons about telehomecare and its impact on patients, nurses, and home health agencies. Determining the direct and indirect costs of this technology will be a major priority. The costs of telehomecare must be analyzed to determine budget requirements as well as feasibility of implementing telehomecare into our health care delivery system. Current telehomecare research is moving from anecdotal reports toward more robust scientific studies. These efforts will result in significant policy and management implications. Rigorous empirical studies with findings that can be generalized across populations and settings are essential.

This article addresses the costs associated with the implementation of a telehomecare intervention, conducted as a randomized field

experiment. Patients' responses[11] and nurses' responses[12] are described elsewhere. Multivariate analyses of clinical outcomes and cost effectiveness are currently underway.

## PROJECT DESCRIPTION

This study investigated the effects of telehomecare on patients and nurses in a large, urban, home health agency. The TeleHomecare Project is a partnership of Pennsylvania State University, The Visiting Nurses Association of Greater Philadelphia, and American Telecare, Inc. (ATI). Funded through the Telecommunications Information Infrastructure Assistance Program (TIIAP), U.S. Department of Commerce, the study began in January, 1997, and ended December, 1998. The purpose of the project was to test the effects of telehomecare on quality of care and to evaluate the financial costs associated with its use in home health services. Specific objectives were to: (1) evaluate health status and quality of life for patients receiving telehomecare; (2) evaluate health care costs associated with a telehomecare project; (3) evaluate patient satisfaction; and (4) extend telehomecare technology to other underserved populations.

### *Sample*

The sample (n = 171) consisted of diabetic patients discharged from the hospital and referred to the VNA of Greater Philadelphia (VNAGP). Patients were randomly assigned to either the intervention group (n = 86) or to the control group (n = 85). One purpose of random assignment is to minimize selection bias; thus, we compared the intervention group and the control group along several dimensions to determine if the groups were equivalent. As illustrated in Table 1, the two groups were comparable, with no significant differences in gender, age, diabetes severity, or number of comorbidities.

Table 1. Patient Characteristics

| | *Telehomecare* | *Control* |
|---|---|---|
| Number of patients | 86 | 85 |
| % Female | 73.6 | 72.9 |
| % Male | 26.4 | 27.1 |
| Average age | 74.8 | 74.2 |
| Mean diabetes severity score | 2.28 | 2.29 |
| Mean number of comorbidities | 1.91 | 2.07 |

### *Procedure*

Patients in the intervention group received video visits in addition to skilled nursing visits, whereas patients in the control group received skilled nursing visits only. A patient station was placed into the intervention group patient's home for 60 days or until discharge from home care. The telehomecare equipment was designed and manufactured by ATI. The patient station had a camera with a close-up lens, medical sensors (sphygmomanometer and stethoscope), and two large buttons (no keyboard) for patient response to audio/visual cues. The clinician station was a Pentium, Windows 95-based computer with a keyboard and mouse that allowed the nurse to manipulate the image acquired by the patient camera and capture still images for medical use. The patient station and clinician station were linked together over ordinary telephone lines via a standard modem.

### *Data collection*

Home health nurses used the Outcomes and Assessment Information Set (OASIS) instrument and a standardized diabetes clinical pathway to measure health status (including diabetes severity), sociodemographic factors, and clinical outcomes. Quality of life was measured using the SF-36, and patient satisfaction surveys were conducted by the research team through telephone interviews. We collected data on admission and at 60 days or discharge, whichever occurred first.

## COST ANALYSIS AND RESULTS

As part of a comprehensive cost-effectiveness assessment, we examined all costs, both direct and indirect. The focus of this analysis was on those costs occurring at the home health agency level. These include labor costs for both the intervention and the control groups and

costs associated with the implementation of the telehomecare system.

*RN costs*

Costs for home visits were calculated at $107.50, the current reimbursable cost for a skilled nursing visit. This cost included labor, benefits, travel, and administrative overhead. Patients in both groups received an average of 18 RN home visits and were in homecare for an average of 50 days. Analysis of the number of RN home visits and the duration of care revealed no statistical difference between the control and intervention group.

Costs for staffing associated with the Tele-Homecare Project, including video visits and other staff activities, were estimated using the Bureau of Labor's most recent figures on average hourly wage ($22.18) for registered nurses in the Philadelphia metropolitan area.[13] The cost of benefits and administrative overhead were added to these figures (see Table 2).

On average, telehomecare patients received 5.5 video visits per episode of care. The labor costs for providing 471 video visits was $5799.43 over the life of the Project, or $3866.29 for 1 year. We monitored the length and frequency of all video visits to determine additional costs incurred as a result of unsuccessful video visits. The nurses occasionally experienced difficulty connecting with patients, requiring rebooting of the unit or the cancellation of the video visit. The quality of the phone lines, the time of day, the speed of the connection, and the location of the unit in the patient's home all affected transmission and concomitant staff time. On average, almost 25% of the video visits were unsuccessful, although this percentage declined as the nurses gained proficiency. The total cost of unsuccessful video visits was $1,226.000 using the amount of clinician time related to this activity.

In addition to RN costs for direct patient care, there were additional labor costs associated with the implementation of the telehomecare system. The nurses were required to learn how to install, calibrate, and operate the equipment, as well as to recognize and fix technical problems. Installation required that the nurse connect the unit to the existing telephone system in the patient's home, a task that often included clearing space for the machine or splicing telephone wires if a wall jack was not available.

Staff costs included time spent by the home health nurses in training, as well as for periodic meetings. Training was required initially and

Table 2. Telehomecare Costs

| | *Project cost*[a] | *One-year cost* | *Total cost/one year* |
|---|---|---|---|
| I. Staff time | | | |
| Video visits [$n$ = 471] | 5799.43 | 3866.29 | |
| Unsuccessful video visits | 1226.00 | 817.00 | |
| Training and meetings | 4970.56 | 2982.00 | |
| Subtotal | | 7665.29 | |
| Benefits @ 24% | | 1839.67 | |
| Administrative overhead @ 33% | | 2529.55 | 12034.51 |
| II. Equipment | | | |
| Patient units (15) and central stations (2)[b] | 91795.00 | 18359.00[c] | |
| Backup drive and printer | 3640.00 | 728.00[c] | |
| Luggage carts and storage bins | 132.00 | 26.40[c] | 19113.40 |
| III. Miscellaneous | | | |
| Insurance | 608.00 | 401.28 | |
| Supplies | 1353.90 | 676.95 | |
| Administrative | 6926.25 | 3463.13 | 4541.36 |
| Total costs | | | 35689.26 |
| $n$ = 86 | | | |

[a]Based on project life of 18 months.
[b]Government rate.
[c]Discounted over 5 years.

throughout the implementation to accommodate changes in the system and software, as well as staffing changes. Additionally, there were costs related to the administration of the project, including case management and patient tracking. These costs were distributed evenly to both the video group and the control group.

Although patients in both groups received care from a variety of professionals (home health aide, physical therapist, social worker, etc.), costs for registered nurses only were used in this analysis. We found no statistical difference between the intervention group and the control group, for either the number of home visits or the duration of home visits involving non-RN professionals, thus eliminating the possibility of confounding results due to services provided by non-RNs.

*System costs*

Fifteen patient stations and two central stations were purchased for the Project. The costs listed in Table 2 are not the actual project costs, because those included substantial research and development expenses. The costs listed in Table 2 are based on current prices (government rate) and portray, more accurately, the state of the telehomecare industry today.

The total cost of the telehomecare units and related peripherals (blood pressure cuffs, cameras, etc.) was discounted over a 5-year period, the estimated life of the equipment. The agency also purchased a backup drive for data security purposes and a printer, so that progress notes from video encounters could be added to the patient's medical record. Both the backup drive and the printer were discounted over a 5-year period.

In addition, the home health agency purchased luggage carts and plastic bins to facilitate transportation and reduce the risk of theft. Concealing the computer equipment reduced the potential for theft and vandalism in patient homes that were in crime-ridden areas. There were no such incidents during the course study.

We estimated the total costs for 1 year of telehomecare services to be $35,689.26. A specific cost breakdown for each component can be found in Table 2.

## DISCUSSION

*Substitution of video visits for home visits*

Our results showed that an episode of care for all patients was approximately 50 days, and patients received an average of 18 RN home visits. Using these results, we forecasted the number of visits for different episodes—30, 60, and 90 days, respectively. The current Medicare reimbursable episode of care is 60 days. To determine the number of potential telehomecare patients per year, we divided 360 days by the number of days in each episode of care, then multiplied the product by 14 (the number of available units, allowing for one unit to be out of service). We then calculated the cost of substituting a specified number of video visits for home visits under two different scenarios and compared these figures to the cost of providing traditional home visits only. Column A represents "Home Visits Only," Column B depicts a ratio of two home visits to one video visit, and Column C illustrates a scenario with equal numbers of home visits and video visits. These calculations are shown in Table 3.

As an illustration, patients who are in homecare for 60 days should expect to receive approximately 22 skilled nursing (RN) visits. In Scenario A, the cost to the home health agency is $2365.00 for traditional RN home visits only. If one video visit is substituted for every third home visit (Scenario B), the cost decreases to $2046.28. However, if one video visit is substituted for every other home visit (Scenario C), the cost decreases further to $1667.80, producing a savings of almost $1000 per patient per episode.

These projections indicate that telehomecare has the potential to provide the same number of patient encounters at lower cost to the home health agency. As shown in Table 3, the longer the patient care episode, the greater the savings.

*Cost considerations*

It is important to evaluate these costs in light of several considerations: the emerging and evolving reliability of the technology, the skill level of the end-users, and the uncertainty regarding the most efficient and effective applications.

Table 3. Telehomecare Costs Per Patient Per Episode—with Substitution of Video Visits

| | *30* | | | *60* | | | *90* | | |
|---|---|---|---|---|---|---|---|---|---|
| *Days of care* | *A* | *B* | *C* | *A* | *B* | *C* | *A* | *B* | *C* |
| RN home visits | 10 | 7 | 5 | 22 | 15 | 11 | 32 | 22 | 16 |
| RN video visits | 0 | 3 | 5 | 0 | 7 | 11 | 0 | 10 | 16 |
| Total visits | 10 | 10 | 10 | 22 | 22 | 22 | 32 | 32 | 32 |
| Total telehomecare patients/year[a] | 0 | 168 | 168 | 0 | 84 | 84 | 0 | 56 | 56 |
| Telehomecare expenses | | | | | | | | | |
| RN Costs | | | | | | | | | |
| Home visits @ $107.5 CPV | 1075.00 | 752.50 | 537.50 | 2365.00 | 1612.50 | 1182.50 | 3440.00 | 2365.00 | 1720.00 |
| Video visits @ $12.88 CPV | | 38.64 | 64.4 | | 90.16 | 141.68 | | 128.8 | 206.08 |
| Unsuccessful video visits @ $1282/year | | 7.63 | 7.63 | | 15.26 | 15.26 | | 22.89 | 22.89 |
| Training and meeting @ $4682/year | | 27.87 | 27.87 | | 55.74 | 55.74 | | 83.61 | 83.61 |
| Indirect expenses | | | | | | | | | |
| Equipment costs @ $18359/year[b] | | 109.28 | 109.28 | | 218.56 | 218.56 | | 327.84 | 327.84 |
| Miscellaneous @ $4541.36/year | | 27.03 | 27.03 | | 54.06 | 54.06 | | 81.10 | 81.10 |
| Cost per patient per episode | 1075.00 | 962.95 | 773.71 | 2365.00 | 2046.28 | 1667.80 | 3440.00 | 3009.24 | 2441.52 |

[a]With 14 active units.
[b]Discounted over 5 years.
*A*, home visits only; *B*, home visits (2): video visits (1); *C*, home visits (1): video visits (1).

Telehomecare is still a new technology. As with any emerging technology, the cost of equipment can be considerable. The costs of acquiring equipment in the early stages of development are high. We believe that as telehomecare technology evolves, equipment costs will continue to decrease. Moreover, as telehomecare technology becomes more prevalent, the potential for the formation of a secondary market may present itself. Home health care agencies may be able to purchase 'used' equipment at significantly reduced costs.

We also believe that substantial amounts of the costs associated with telehomecare implementation rest in developing the skill levels of the end users. Some patients had difficulty operating the equipment, raising questions regarding selection of the most appropriate candidates for use. As previously mentioned, nurses occasionally experienced difficulty operating the system. Because many of the nurses participating in this study had minimal exposure to computers, several expressed anxiety regarding their keyboarding skills when using the central station. Many nurses were reluctant to switch to typewritten nurse's notes and preferred to document video visits using both the electronic record and handwritten notes. We noted a significant learning curve at both the patient and clinician level, yet believe, as this technology becomes more pervasive, end users will become increasingly comfortable and efficient. In addition, during the period of this study, three generations of telehomecare machines were introduced and tested. This forced end users to continually develop new skills to master, and overcome new technical and operational difficulties.

The use of the Bureau of Labor's average hourly wage requires further consideration. The Bureau's figure encompasses factors that contribute to the wage rate of a specific metropolitan area including the level of unionization and degree of urbanization. While this figure was the most appropriate for our analysis, it may not be appropriate for agencies in all markets.

We found very meaningful trends in clinical outcomes that can translate into cost savings. Fewer telehomecare patients required recertification after 60 days (23% versus 25.6% of control group patients, $p < 0.001$), and 63.7% of the telehomecare patients were discharged to home compared to 39% of the control group patients ($p < 0.01$). More importantly, 28% of the control patients were hospitalized during the 60-day intervention, compared to 10% of the telehomecare patients ($p < 0.05$). These results suggest that the cost-effectiveness of telehomecare is even more impressive when considering a full array of services. The average hospitalization cost for a diabetes stay without complications (DRG 49) for a Medicare patient in an urban area was $9,703 in 1997.[14] Using our data, we estimated hospitalization costs to be $87,327 for telehomecare patients and $232,872 for control group patients. This is a conservative estimate because most patients in our study had one or more co-morbidities, which could result in higher hospitalization costs and therefore greater savings. A comprehensive cost-effectiveness analysis is underway. Further study will determine when and how telehomecare may substitute for traditional home visits.

## CONCLUSIONS

Results show that potential savings through fewer home visits offset the additional costs that telehomecare imposes to the home health agency. Thus, under a prospective payment system, the home health agency can provide more encounters while reducing total contact time. Prior studies suggest that telehomecare technology can provide video contact with 15–25 patients a day while, on average, a mobile visiting nurse can only see 5.2 patients per/day.[8] In addition, the same patient can be monitored two or more times a day.

Furthermore, our results show that total costs per patient per episode, including hospitalization, are lower for the telehomecare patients than for the control group patients, supporting the Kaiser-Permanente study.[10]

The next step for home health managers and researchers is to determine the appropriate number of video visits, i.e., substitution versus supplementation. One of the goals of this project was to assess the effectiveness of telehomecare from both a cost and clinical perspective.

This study's design will provide effectiveness data that has been lacking in telehomecare assessment. On the basis of our results, future research should focus on the appropriate mix of video and traditional visits, using health status and adverse events as outcomes.

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