

## Original Research

# Economic Evaluation of Interactive Teledermatology Compared with Conventional Care

APRIL W. ARMSTRONG, M.D.,<sup>1</sup> DAVID J. DORER, Ph.D.,<sup>2</sup> NANCY E. LUGN, J.D., M.B.A.,<sup>3</sup>  
and JOSEPH C. KVEDAR, M.D.<sup>4</sup>

### ABSTRACT

Teledermatology offers a means of providing specialist care to underserved patients. The objectives of this study were to compare the costs of interactive teledermatology with conventional care, and to evaluate from a healthcare provider perspective whether interactive teledermatology is economically viable in the northeastern region of the United States. We studied the interactive teledermatology practice at Nantucket Cottage Hospital on Nantucket Island and the ambulatory clinics at the Massachusetts General Hospital in Boston, Massachusetts. The cost-minimization analysis compared the costs of an interactive teledermatology practice with that of a face-to-face dermatology clinic. One-way sensitivity analyses examined the effect of varying the costs of technology, physician compensation, or clinic space on the overall cost of interactive teledermatology. We also assessed the economic viability of the interactive teledermatology practice by comparing the operating costs with reimbursements. The total hourly operating costs for the interactive teledermatology practice on Nantucket Island and the face-to-face clinic in Boston were \$274 and \$346, respectively. Three separate one-way sensitivity analyses showed that, for the cost of the teledermatology practice to equal that of the conventional clinic, the cost of teledermatology technology could increase by 9.3-fold, dermatologists working at the teledermatology practice could be compensated up to \$197 an hour, or the cost of teledermatology clinic space could reach \$57 an hour. Our analysis also showed that the hourly reimbursement for the teledermatology practice was \$487, which exceeded its hourly operating cost of \$274. The cost of operating an interactive teledermatology practice in a remote region may be less than that of a conventional clinic in a nearby urban center in the northeastern area of the United States. From a healthcare provider perspective, interactive teledermatology can be an economically viable means of providing dermatological care to remote regions.

### INTRODUCTION

**T**HE DEMAND FOR SPECIALIZED DERMATOLOGY CARE has grown considerably in recent

years. Patient access to dermatological care is especially limited in remote regions, where few dermatologists are available. Teledermatology as a means of providing dermatological care in

<sup>1</sup>Department of Dermatology, Massachusetts General Hospital, Boston, Massachusetts. <sup>2</sup>Biostatistics Center, Massachusetts General Hospital, Boston, Massachusetts.

<sup>3</sup>Perceptive Informatics, Inc., Waltham, Massachusetts.

<sup>4</sup>Department of Dermatology, Partners Telemedicine, Massachusetts General Hospital, Boston, Massachusetts.

these regions has been studied extensively over the past 10 years.<sup>1-5</sup> Two primary methods used in teledermatology are interactive (video-conferencing) teledermatology and store-and-forward teledermatology. Studies have demonstrated comparable clinical efficacy and diagnostic accuracy of interactive teledermatology to conventional outpatient care.<sup>6-9</sup> Wide adoption of interactive teledermatology in remote regions requires economic feasibility of this care delivery system. This study compares the costs of an interactive teledermatology practice with that of face-to-face conventional clinics and assesses the economic viability of interactive teledermatology in the northeastern region of the United States.

There have been few studies evaluating the health economics of interactive teledermatology. Wootton et al. investigated health economics of interactive teledermatology in the United Kingdom and New Zealand from a societal perspective.<sup>10-13</sup> When comparing interactive teledermatology with conventional care in the United Kingdom, their studies found that the costs of interactive teledermatology were higher than the costs of conventional care in both urban and rural areas; nevertheless, from a societal perspective, teledermatology could be a cost-effective alternative to conventional care if the equipment was priced lower and patients traveled greater distances for conventional care.<sup>10,12</sup> In New Zealand, the geographical distance between the patient and care provider was substantial such that, from a societal perspective, interactive teledermatology was found to cost less than conventional care.<sup>11</sup> The store-and-forward care delivery system was less expensive than interactive teledermatology in the United Kingdom; but it was clinically less efficient and limited the dermatologist's ability to obtain relevant clinical information.<sup>13</sup>

Although studies from the United Kingdom and New Zealand provide a useful starting point to address the economics of interactive teledermatology, healthcare delivery and health economics differ considerably in the United States.<sup>14-16</sup> To date, no study has performed an economic analysis of interactive teledermatology in the United States. As the technology of teledermatology has matured, the

cost of this technology has steadily decreased.<sup>17</sup> Now is an opportune time to examine, from a healthcare provider perspective, whether interactive teledermatology is an economically viable means of providing dermatological care to patients in the remote areas. Our study assessed the cost and revenue of operating an interactive teledermatology practice located on Nantucket Island, Massachusetts. We compared the operating cost of the teledermatology practice to that of a conventional face-to-face clinic in a nearby urban center. We hypothesized that, from a healthcare provider perspective, the cost of operating a teledermatology clinic would be comparable to that of an outpatient dermatology clinic in the United States. We adopted the healthcare provider perspective because healthcare providers are more likely to adopt interactive teledermatology if it is an economically viable operation.

In the United States, the New England region has a number of remote islands that can benefit from teledermatology. Nantucket Island is located 30 miles southeast of the Massachusetts mainland and 100 miles from Boston. The Nantucket Cottage Hospital is the sole hospital serving an island population of 10,000 full-time residents and an additional 40,000 visitors during the summer months. Nantucket Island does not have a dermatologist, and prior to the advent of teledermatology, patients from the island would travel at least 30 miles by sea to receive dermatological care at a community hospital or 100 miles to receive dermatological care at an urban center (Boston). The interactive teledermatology practice at Nantucket Cottage Hospital is the subject of this economic analysis.

## MATERIALS AND METHODS

### *Teledermatology practice and conventional clinic*

The interactive teledermatology practice in the Nantucket Cottage Hospital was established on July 23, 2003. From July 2003 through January 2005, 451 new-patient and follow-up visits were made to the interactive teledermatology clinic. The 2-hour clinic session occurred weekly and accommodated four patients an

hour. According to the Center for Medicare and Medicaid Services (CMS), the originating site of an interactive teledermatology practice is defined as the site where patients are being treated, and the distant site is the site where the clinician or evaluator is situated, which is not proximate to the primary site of the activity.<sup>18</sup> With the assistance of a nurse practitioner at the Nantucket Cottage Hospital (originating site), a dermatologist in Boston (distant site) evaluated patients via interactive videoconferencing. In preparation for the clinic, the patient's medical history was sent to the dermatologist 24 hours in advance. On the day of the clinic, the dermatologist took a full clinical history and performed a physical examination via a high-resolution camera (see Teledermatology Equipment below) with the nurse practitioner's assistance. If a lesion required further examination, the dermatologist asked the nurse practitioner to position the camera for a close-up visualization of the lesion. The nurse practitioner has been trained to perform basic dermatological procedures, such as skin biopsies, destruction of benign and premalignant lesions, removal of skin tags, and intralesional injections. If a patient required an excision, the patient was typically referred to the Nantucket Island general surgeon. Almost all pathology specimens were sent to the Cape Cod Hospital for pathologic evaluation, with occasional, complex cases sent to the Massachusetts General Hospital for review. The general dermatology clinics (Dermatology Associates) at the Massachusetts General Hospital (MGH), located in Boston, comprised the comparison arm of the conventional, face-to-face clinics. MGH is an academic hospital that primarily serves the patient population in the greater Boston area; it is also a large referral center for patients with unique, complicated pathologies that warrant further evaluation. Although MGH is primarily an academic hospital, the operation and billing of the dermatology clinics are conducted under a private billing system.

#### *Teledermatology equipment*

To operate an interactive teledermatology practice, both the originating site and distant

site must be equipped with proper videoconferencing hardware and network connection. The Nantucket Cottage Hospital teledermatology practice is equipped with a Polycom ViewStation 512, an AMD 2500 camera (horizontal resolution greater than 430 lines), and a Nikon Coolpix with Dermlite Lens. The Polycom ViewStation at the originating site is a videoconferencing unit connected to a television monitor. The AMD 2500 camera, equipped with power zoom, freeze-frame capture, and electronic image polarization, permits close-up examination of skin lesions. The Nikon Coolpix with Dermlite Lens captures images under a polarization system and was used to examine pigmented lesions. Videoconferencing is conducted via Internet Protocol (IP) using the public Internet and the H.323 standard for video conference transmissions. The transmission is secured by encryption using the AES encryption standard. In a 2-hour teledermatology session, approximately 3 gigabytes of Internet connectivity were used. At the distant site, a dermatologist interacts with patients at Nantucket via a Tandberg 1000 videoconference station.

#### *Cost data collection and analysis*

A cost minimization analysis was performed from the healthcare provider perspective. Cost data for the two types of practices were obtained from the finance departments of the Nantucket Cottage Hospital and MGH. Costs were categorized into teledermatology technology cost, facility and personnel overhead, and physician compensation. For the teledermatology practice, technology cost included teledermatology hardware, maintenance, teledermatology staff training, and incremental network connection charges. The yearly cost of the hardware was computed from a straight-line depreciation over 5 years of the purchase price.<sup>19</sup> The hardware and software maintenance cost was specified in the purchasing agreement with Partners Telemedicine. Videoconferences were conducted through IP over standard networking connectivity to the Internet. Partners Telemedicine has marginal use of an existing Partners IP network. Incremental network connection charges were calculated



AU1



AU2

according to the metered rates for utilized bandwidth at MGH. Two staff members, the nurse practitioner at the originating site, and the dermatologist at the distant site each received 4 hours of training in the use of teledermatology equipment.

For the teledermatology practice, facility and personnel overhead included the cost of the clinic space, the dermatologist's administrative office space, materials and supplies, a nurse practitioner, and technical support personnel. At the originating site, the cost of the single 80-square-foot examination room at the Nantucket Cottage Hospital was based on the hourly rental charge to consultants. At the distant site, the dermatologist uses his administrative office space to conduct the teledermatology clinic. The hourly cost for this 80-square-foot administrative office was calculated from the yearly rental charge and is based on the hourly rental charge to the consulting dermatologist. The hourly compensation for the nurse practitioner at the teledermatology practice was calculated from the annual salary with fringe benefits. The hourly compensation for the technology support personnel was predetermined in a tele-dermatology practice contract. Similarly, the hourly compensation for the dermatologist at the distant site was specified by the teledermatology practice contract between the Nantucket Cottage Hospital and the dermatologist.

For the face-to-face, conventional dermatology clinics at MGH, the cost of the 80-square-foot clinic space was based on the hospital's building charge for clinic space at the Ambulatory Center. The conventional clinic employed secretaries, medical assistants, and licensed practical nurses, whose hourly compensations were calculated from their annual salary with fringe benefits. The cost of a 4-hour staff training session for the medical supporting staff was also included. The hourly physician compensation at the conventional clinic was calculated from the sum of yearly salary and fringe benefits.

A cost-minimization analysis compares the costs of multiple interventions that provide the same outcome for the purposes of identifying the lowest-cost intervention.<sup>20</sup> We conducted a cost-minimization analysis comparing the cost

of a teledermatology clinic with that of an outpatient, face-to-face dermatology clinic. Sensitivity analyses show how changes in certain variables could affect the outcome of an economic analysis. One-way sensitivity analyses, in which a single variable was tested over its range of plausible values while all other variables were held constant,<sup>21</sup> were applied to the cost of teledermatology technology, physician compensation, and the cost of clinic space, respectively.

To assess economic viability of the teledermatology practice, the hourly revenue was compared with the total hourly operating cost. The revenue from the teledermatology clinic was based on its reimbursement data. The number of visits, visit type, reimbursement for each visit, number of procedures, and reimbursement for each procedure were collected from July 2003 to January 2005. Dermatologic procedures included skin biopsies, destruction of benign and premalignant lesions, removal of skin tags, and intralesional injections. Excisions were not included in the analysis because these procedures were not performed in the teledermatology clinic. The average reimbursement for each visit was calculated by dividing the total reimbursement (from new visits, follow-up visits, and procedures) by the number of unique visits.

#### *Visit-type comparison*

Case-mix data were collected from both the teledermatology practice as well as the conventional clinics at MGH from July 2003 to January 2005. From both practices, the primary diagnoses for each unique visit were collected based on the International Classification of Disease (ICD) billing forms. For the conventional clinics, visit information was collected from the general dermatology clinics at MGH. Visit information from the following dermatology specialty clinics was excluded from the visit-type comparison: dermatological surgery, laser and cosmetics, phototherapy, and pigmented lesions clinic. The top five primary diagnoses were tabulated from both practices, and comparison was made to assess whether the range of dermatological diseases was similar between the two practices.

## RESULTS

*Cost-minimization analysis*

**T1** The costs of operating a teledermatology practice were grouped into teledermatology technology cost, facility and personnel overhead, and physician compensation (Table 1). The subtotal cost of teledermatology technology amounted to \$4.75 an hour. The cost of renting and maintaining an 80-square-foot clinic space at the Nantucket teledermatology clinic was \$12.50 an hour. To corroborate this finding, we inquired about the cost of clinic space at North Berkshire Health Center, a community health center located in rural, northwestern Massachusetts. At North Berkshire Health Center, the cost of renting an 80-square-foot outpatient clinic space was \$9.25 an hour, which was comparable to the hourly rental of \$12.50 at the Nantucket teledermatology clinic. The hourly cost of renting a dermatologist's administrative office for the teledermatology practice was \$1.38 an hour. The cost of materi-

als and supplies for each patient was \$10; with four patients evaluated each hour, the hourly cost of materials and supplies amounted to \$40. The hourly compensation for the nurse practitioner and the technical support personnel was \$40 and \$50, respectively. The hourly physician compensation for the medical dermatologist at the distant site was \$125, as specified by the existing contract.

For the conventional clinic, the cost of renting and maintaining an 80-square-foot clinic space at the Ambulatory Center of MGH in Boston was \$100 an hour. The cost of materials and medical supplies was the same as that for the teledermatology clinic. Hourly compensation for the medical supporting staff and a medical dermatologist was calculated based on average yearly incomes. The hourly compensation for a medical dermatologist at the conventional clinic was \$153. As Table 1 shows, the hourly total operating costs for the teledermatology practice and the conventional clinic were \$274 and \$346, respectively.

TABLE 1. HOURLY COSTS OF TELEDERMATOLOGY PRACTICE VERSUS CONVENTIONAL CLINIC

	<i>Interactive teledermatology practice</i>	<i>Conventional clinic</i>
Teledermatology technology cost		
Originating site (Nantucket Cottage Hospital)		
Polycom ViewStation	\$0.47	\$0.00
AMD 2500 camera	\$0.48	\$0.00
Nikon Coolpix with DermLite Lens	\$0.11	\$0.00
Maintenance	\$0.30	\$0.00
Distant site (dermatologist in Boston)		
Tandberg 1000	\$0.56	\$0.00
Maintenance	\$0.30	\$0.00
Network connection	\$2.50	\$0.00
Teledermatology staff training	\$0.03	\$0.00
Teledermatology subtotal	\$4.75	\$0.00
Facility and personnel overhead		
Clinic space	\$12.50	\$100.00
Dermatologist's administrative office	\$1.38	\$0.00
Materials and supplies	\$40.00	\$40.00
Secretary	\$0.00	\$17.00
Medical Assistant	\$0.00	\$14.00
Nurse practitioner/Licensed practical nurse <sup>a</sup>	\$40.00	\$22.00
Office staff training	\$0.00	\$0.04
Technical support personnel	\$50.00	\$0.00
Facility and personnel subtotal	\$144.00	\$193.00
Physician compensation <sup>b</sup>	\$125.00	\$153.00
Total hourly cost of the clinic	\$273.66	\$346.04

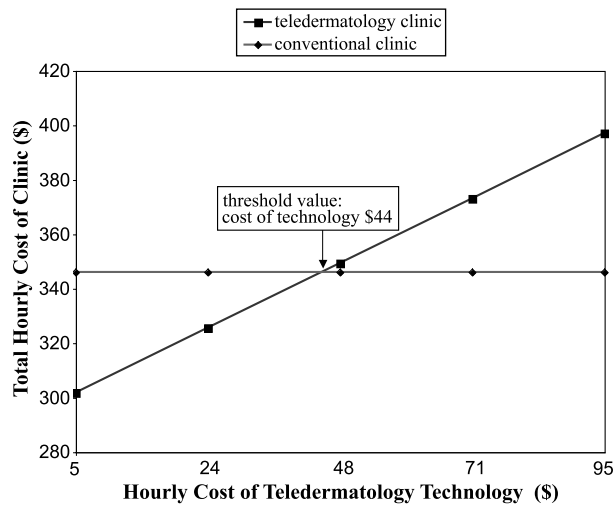


FIG. 1. One-way sensitivity analysis on the hourly cost of teledermatology technology. With all other variables held constant, the cost of technology was varied to examine its effect on the total cost of the clinic. Physician compensation was held equal (\$153) between the two clinics. The threshold value, or the point where the costs of the two practices became equal, was reached when technology cost rose to \$44 (9.3-fold of the current cost).

Sensitivity analyses

A one-way sensitivity analysis varying the cost of teledermatology technology was performed to determine how changes in technology cost would influence the overall costs of teledermatology practice (Fig. 1). The current hourly cost of the teledermatology technology was \$4.75. In this analysis, it was assumed that physician compensation was equal in both practices at \$153 an hour. The threshold value, the point at which the cost of operating a teledermatology clinic was equivalent to that of the conventional face-to-face clinic, occurred at \$44 an hour. This is a 9.3-fold increase from the \$4.75 technology cost incurred in the teledermatology practice. Similarly, a one-way sensitivity analysis varying the cost of physician compensation in the teledermatology clinic was performed (Fig. 2). The hourly dermatologist compensation in the teledermatology practice could reach \$197 (the threshold value), before the overall costs of the two clinics became equal. This analysis was based on the hourly technology cost of \$4.75. A third one-way sensitivity analysis varying the cost of clinic space (80-square foot) showed that the cost of the tele-

dermatology clinic space could increase to \$57 an hour before the overall costs of the two clinics became equal (Fig. 3). This one-way sensitivity analysis was also conducted with the assumption that physician compensation between the two practices was equal at \$153 an hour.

Cost-reimbursement comparison of teledermatology practice

For the teledermatology practice, the total hourly operating cost was compared with its hourly reimbursement. Table 2 shows the reimbursement data for the teledermatology clinic. The reimbursement for each new visit averaged \$97, each follow-up visit \$67.50, and each minor procedure \$148. The average reimbursement for each visit was \$121.60. Our data showed that, with four patients evaluated each hour, the hourly reimbursement for the teledermatology practice was \$487, which exceeded the hourly operating cost of \$274.

Visit-type comparison

To compare the range of dermatological diseases seen at the teledermatology practice and the conventional clinics, primary diagnoses for each visit were collected from both practices

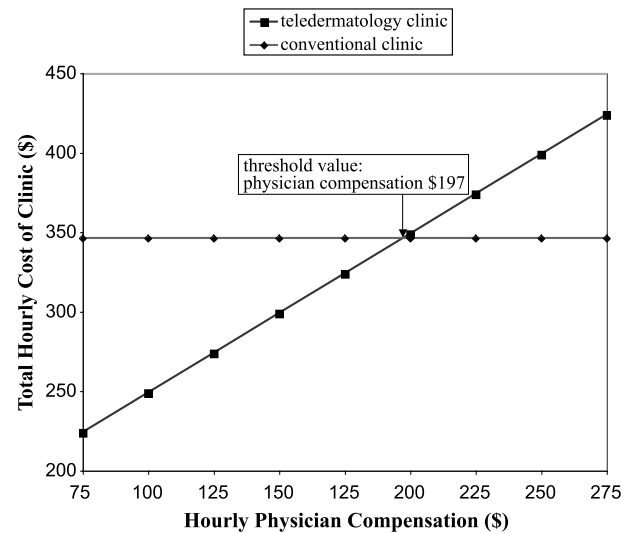


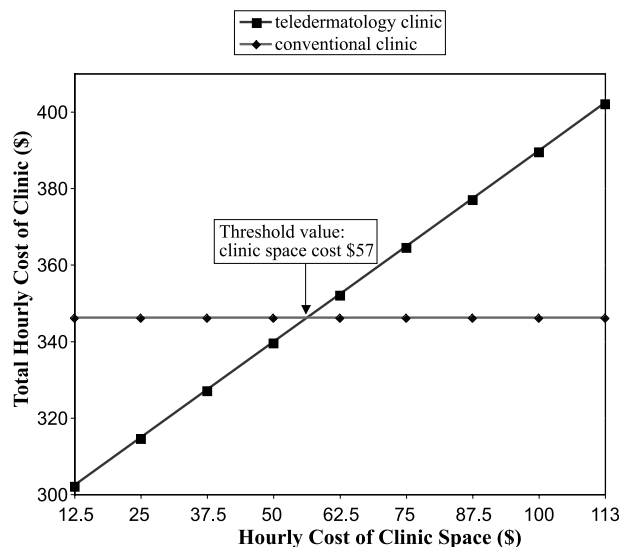
FIG. 2. One-way sensitivity analysis on the hourly cost of physician compensation. With all other variables held constant, physician compensation was varied to examine its effect on the total cost of the clinic. The threshold value, or the point where the costs of the two practices became equal, was reached when physician compensation rose to \$197 an hour.

F1

F2

F3

T2



**FIG. 3.** One-way sensitivity analysis on the hourly cost of clinic space. With all other variables held constant, the cost of the teledermatology clinic space (80-square-foot) was varied to examine its effect on the total cost of the clinic. Physician compensation was held equal (\$153) between the two clinics. The threshold value, or the point where the costs of the two practices became equal, was reached when the cost of the clinic space rose to \$57.

**T3** (Table 3). Among 451 unique visits at the teledermatology practice during this period, the five most frequent diagnoses were actinic keratosis (13.4%), eczema due to unspecified cause (12.2%), acne and other specific diseases of the sebaceous glands (11.9%), benign neoplasm (9.1%), and viral infections (5.2%). Out of 47,434 unique visits at the general dermatology clinics at MGH, the most frequent five diagnoses were actinic keratoses (13.0%), benign neoplasm (11.6%), acne and other specific diseases of sebaceous glands (8.8%), eczema due to unspecified cause (7.5%), and viral infections (7.4%). These results showed that there were no significant differences in the frequency of common diseases between the two clinics.

## DISCUSSION

In this study, the hourly cost of operating the teledermatology practice was lower than that of the conventional clinic (\$274 versus \$346). Two main factors contributed to the low cost of the teledermatology clinic—low costs of technology (\$4.75) and clinic space (\$12.50). As with any rapidly evolving technology, the cost of telemedicine technology can vary depending on its novelty, versatility, and degree of adoption. As the technology for telemedicine has matured, the equipment cost has declined while the quality of the interactive interface has improved.<sup>17</sup> The hourly cost of the teledermatology hardware and network connectivity represented a small proportion of the overall clinic expense. The use of the public Internet has replaced expensive Integrated Service Digital Network (ISDN) lines, which in the past accounted for a significant portion of the technology cost.<sup>6,10,11</sup> The one-way sensitivity analysis showed that the cost of technology would need to increase by 9.3-fold before the overall costs of the two types of clinics converged.

The cost of clinic-space rental was the second factor contributing to the low cost of operating the teledermatology clinic. Teledermatology clinics are typically located in rural areas where patients have limited access to dermatologic care, but the cost of space in these rural areas is considerably lower than in the nearest urban area. In this study, the cost of clinic-space rental was significantly lower in Nantucket than in Boston. Similar lower cost of clinic-space rental was observed at the North Berkshire Health Center, a community health center in rural Massachusetts. Building charges for the MGH clinic space may be slightly higher than that of clinic spaces in less central areas of Boston. One-way sensitivity analysis showed that the

TABLE 2. TELEDERMATOLOGY PRACTICE REIMBURSEMENT (JULY 2003 TO JANUARY 2005)

Visits	No. of visits	Reimbursement per visit	Total reimbursement
New visits	301	\$97.00	\$29,264.00
Follow-up visits	150	\$68.00	\$10,129.00
Minor procedures <sup>a</sup>	104	\$148.00	\$15,435.00
Average reimbursement per visit	\$122		
Reimbursement per hour	\$487		

TABLE 3. VISIT TYPE COMPARISON BETWEEN TELEDERMATOLOGY PRACTICE AND CONVENTIONAL CLINIC

<i>Rank of frequency</i>	<i>Teledermatology practice (451 visits)</i>	<i>MGH General Dermatology Clinic (47,434 visits)</i>
1	Actinic keratosis (13.4%)	Actinic keratosis (13.0%)
2	Eczema due to unspecified cause (12.2%)	Benign neoplasm (11.6%)
3	Acne and other diseases of sebaceous glands (11.9%)	Acne and other diseases of sebaceous glands (8.8%)
4	Benign neoplasm (9.1%)	Eczema due to unspecified cause (7.5%)
5	Viral infections (5.2%)	Viral infections (7.4%)

hourly rental cost of the teledermatology clinic space could increase to \$57 before the total costs of these two types of clinics converged.

Although it is recognized that teledermatology practices benefit patients in rural areas by providing specialist care that would otherwise be unavailable or difficult to obtain, this study also strongly suggests that a teledermatology practice can provide adequate dermatologist compensation and be an economically viable operation. The one-way sensitivity analysis revealed that, when compared to a colleague working in a conventional clinic located in an urban area with \$153 hourly compensation, a dermatologist at the teledermatology clinic could receive hourly compensation of up to \$197 before the costs of the two types of clinics converged. Physician compensation for the dermatologist at the teledermatology clinic was comparable to that of conventional practice, which could attract dermatologists to teledermatology practices. However, in urban areas where provider shortage is a concern, healthcare providers need to be cognizant of "patient displacements," that is, allocation of specialist resource to teledermatology clinics may draw from the scarce resource pool necessary to provide care to patients in urban centers. From a societal perspective, when the demand for dermatological care in both urban and remote regions exceeds dermatology resources, equitable allocation of dermatology resources must be carefully considered.

In addition to the competitive physician compensation it could offer, the teledermatology practice generated greater reimbursement than its costs. The hourly revenue of \$487 exceeded the total expenditure of \$274. It is important to recognize that teledermatology visits are reimbursed in the same manner as if the clinical interaction occurred face-to-face. The

current patient population at the Nantucket teledermatology clinic reflects a developing dermatology practice rather than an established one, because the proportion of new visits significantly outweighs that of follow-up visits. The visit-type comparison showed that the most common types of dermatological diseases seen at the two types of practices were similar.

This study had several limitations. First, the Nantucket teledermatology clinic and the conventional outpatient clinics were located in the northeast region of the United States. Regional differences in clinic operations may exist within the United States and could account for significant variations in practice costs. Second, the perspective of the healthcare provider was employed in this study, which does not allow us to draw conclusions from a societal perspective. This study adopted the perspective of the healthcare providers because this group plays a key role in deciding whether to establish and maintain teledermatology practices. Additionally, the financial benefit of teledermatology clinics to patients and society has already been demonstrated in literature.<sup>6,10,11</sup> Third, although negligible network-connection cost was incurred in our study because teledermatology interface occurred over public Internet with encryption, sites that continue to use ISDN lines would incur a greater technology cost.

In this study, we found that, in Massachusetts, the cost of operating an interactive teledermatology clinic in a remote region was lower than that associated with operating a conventional, face-to-face dermatology clinic at an urban area. The lower cost of the teledermatology practice was primarily related to the low cost of technology and reduced rental charge for clinic space in rural areas. This study also

showed that the compensation for dermatologists who conduct interactive teledermatology clinics was at least as competitive as that for dermatologists working in face-to-face, conventional academic clinics in urban areas. This study suggests that teledermatology clinics could be an economically viable operation in the northeast region of the United States. Wider adoption of teledermatology clinics should be encouraged in rural areas as a means toward providing improved access to specialist care.

### ACKNOWLEDGMENTS

We would like to acknowledge and thank the following individuals for their support and contribution to this study: Richard Clark, Brian Hammond, Linda Maljovec, Douglas McClure, Patricia Sullivan, Dr. Arthur Sober, and Courtney Trautman.

### REFERENCES

1. Kvedar JC, Menn ER, Baradagunta S, Smulders-Meyer O, Gonzalez E. Teledermatology in a capitated delivery system using distributed information architecture: design and development. *Telemed J* **1999**;5:357–366.
2. Whitten PS. Teledermatology delivery modalities: Real time versus store and forward. *Curr Probl Dermatol* **2003**;32:24–31.
3. Al-Qirim NA. Teledermatology: The case of adoption and diffusion of telemedicine health Waikato in New Zealand. *Telemed J E Health* **2003**;9:167–177.
4. Whited JD. Teledermatology. Current status and future directions. *Am J Clin Dermatol* **2001**;2:59–64.
5. Eedy DJ, Wootton R. Teledermatology: A review. *Br J Dermatol* **2001**;144:696–707.
6. Loane MA, Corbett R, Bloomer SE, et al. Diagnostic accuracy and clinical management by realtime teledermatology: Results from the Northern Ireland arms of the UK Multicentre Teledermatology Trial. *J Telemed Telecare* **1998**;4:95–100.
7. Phillips CM, Burke WA, Shechter A, Stone D, Balch D, Gustke S. Reliability of dermatology teleconsultations with the use of teleconferencing technology. *J Am Acad Dermatol* **1997**;37:398–402.
8. Leshner JL, Davis LS, Gourdin FW, et al. Telemedicine evaluation of cutaneous diseases: A blinded comparative study. *J Am Acad Dermatol* **1998**;38:27–31.
9. Lowitt MH, Kessler II, Kauffman L, Hooper FJ, Siegel E, Burnett JW. Teledermatology and in-person examinations. *Arch Dermatol* **1998**;38:27–31.
10. Loane MA, Bloomer SE, Corbett R, et al. A randomized controlled trial assessing the health economics of realtime teledermatology compared with conventional care: An urban versus rural perspective. *J Telemed Telecare* **2001**;7:108–118.
11. Loane MA, Oakley A, Rademaker M, et al. A cost-minimization analysis of the social costs of realtime teledermatology compared with conventional care: Results from a randomized controlled trial in New Zealand. *J Telemed Telecare* **2001**;7:233–238.
12. Wootton R, Bloomer SE, Corbett R, et al. Multicentre randomized control trial comparing real time teledermatology with conventional outpatient dermatological care: Societal cost-benefit analysis. *BMJ* **2000**;320:1252–1256.
13. Loane MA, Bloomer SE, Corbett R, et al. A comparison of interactive and store-and-forward teledermatology: A cost-benefit study. *Br J Dermatol* **2000**;143:1241–1247.
14. Steiner A, Robinson R. Managed care: US research evidence and its lessons for the NHS. *J Health Serv Res Policy* **1998**;3:173–184.
15. Rosenau PV. Managing medical technology: Lessons for the United States from Quebec and France. *Int J Health Serv* **2000**;30:617–639.
16. Anell A, Willis M. International comparison of health care systems using resource profiles. *Bull World Health Organ* **2000**;78:770–778.
17. Norris AC. Technology of telemedicine systems. In: *Essentials of telemedicine and telecare*. West Sussex, England: John Wiley & Sons, **2002**. ← AU4
18. Greenberg D, Zellinger J. Medicaid and telemedicine. Available at: <http://www.cms.hhs.gov>. Last accessed April 10, **2005**.
19. Figuring depreciation under MACRS. Available at <http://www.irs.gov/publications/p946/ch04.html#d0e4596>. Last accessed April 10, **2005**.
20. Ellis CN, Reiter KL, Wheeler JRC, et al. Economic analysis in dermatology. *J Am Acad Dermatol* **2002**;46:271–283.
21. Muennig P. Conducting a sensitivity analysis. In: *Designing and conducting cost-effectiveness analysis in medicine and health care*. San Francisco, CA: Jossey-Bass, **2002**. ← AU5

AU3 →

Address reprint requests to:  
 April W. Armstrong, M.D.  
 Department of Dermatology  
 Massachusetts General Hospital  
 55 Fruit Street, Bartlett Hall 616  
 Boston, MA 02114.

Email: [awarmstrong@partners.org](mailto:awarmstrong@partners.org)

## **ARMSTRONG**

### **AU1**

**pls add mfg, city, & state for these products**

### **AU2**

**pls. give mfg, city, & state for Tandberg 1000.**

### **AU3**

**Pls. add rest of authors for all "et al." refs (6,8,10–13,20)**

### **AU4**

**Add editor(s), if any Also add page range**

### **AU5**

**Please add Editors and chapter page rang**