Comparison of Skin Biopsy Triage Decisions in 49 Patients With Pigmented Lesions and Skin Neoplasms

Store-and-Forward Teledermatology vs Face-to-Face Dermatology

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Objective: To determine the relative efficacy of store-and-forward teledermatology vs face-to-face dermatology consultations in triage decisions about the need for a biopsy of neoplastic skin changes.

Design: Prospective study of consecutive patients judged by an internist to require dermatologic consultation for a skin growth.

Setting: Private primary care and dermatology practices and an academic dermatology practice.

Patients: Patients requiring dermatology consultation for evaluation of skin growths. Patients were seen by a single primary care physician between July 10, 1998, and August 4, 2000.

Intervention: Digital photographs of skin growths were obtained by the primary care physician and evaluated by a teledermatologist. The patient was then seen face-to-face by a dermatologist. A biopsy was performed if either dermatologist favored biopsy.

Main Outcome Measures: Decisions to perform a biopsy. Agreement between the dermatologists was assessed.

Results: Of the 49 patients with evaluable photographs, the face-to-face dermatologist and teledermatologist recommended a biopsy for the same 26 patients, yielding a sensitivity of the teledermatologist of 1.00 (95% confidence interval [CI], 0.87-1.00) and a specificity of 1.00 (95% CI, 0.85-1.00). The agreement between the dermatologists (κ) was 1.00 (95% CI, 0.72-1.00).

Conclusion: Store-and-forward teledermatology may provide an accurate and cost-effective method of determining whether skin growths in patients presenting to primary care physicians should undergo biopsy.

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Teledermatology, a rapidly growing discipline fueled by factors related to access, quality, and cost of care, has the potential to help address the need for rapid access to dermatology by primary care physicians (PCPs). Although multiple studies have shown that PCPs are ill-prepared to diagnose common skin diseases1-9 and report uncertainty regarding management of more than 1 of every 3 dermatology cases, PCPs refer fewer than 1 in 10 of these cases.10 In rural areas undersupplied with dermatologists, referral rates for skin problems are 1% to 2% or less.11

Access to urban dermatologists is limited by a relative undersupply of dermatologists12 and by market forces such as managed care organizations. In reflection of this trend, the average wait for an appointment at the University of Pennsylvania Department of Dermatology, Philadelphia, is 12 weeks. To expedite dermatologic evaluations and improve access to dermatology, the authors undertook an evaluation of the efficacy of store-and-forward (SAF) teledermatology consultations in the setting of a primary care practice. This study aimed to assess whether a teledermatologist, compared with a face-to-face (FTF) dermatologist, could effectively triage patients with respect to the need for a biopsy.

METHODS

The study was approved by the Institutional Review Board of the Hospital of the University of Pennsylvania. To compare the diagnostic performance of the teledermatologist (W.D.J.) and FTF dermatologist (F.C.L.), both of whom have more than 20 years of experience in clinical dermatology, the 2 study physicians were shown 10 clinical slides of skin growths accompanied by a brief history. For
Triage of patients with skin growths who underwent a face-to-face dermatology evaluation and a store-and-forward teledermatology evaluation.

Each slide, they were asked to provide a clinical diagnosis and choose a management plan from a list of 15 entries, including 3 biopsy plans (to rule out malignancy, to establish a diagnosis, or to remove a benign lesion for cosmetic purposes).

A network community PCP (R.K.) recruited 61 consecutive patients whom he judged to require dermatologic consultation for evaluation of a cutaneous growth between July 10, 1998, and August 4, 2000, to participate in the study. An estimated 50% of the PCP’s patients have dermatologic issues that are encountered during a routine evaluation, and 3% present exclusively for dermatologic concerns. Our PCP, who is board certified in internal medicine since 1984, referred only those patients with skin growths that posed a true diagnostic challenge. Patients who underwent previous evaluation by a dermatologist were excluded from the study. All patients signed an informed consent, which included permission to transmit photographs over the Internet.

Images were acquired by the PCP using an Olympus D-600L digital camera (Olympus America Inc, Melville, NY), which produces 1.4-megapixel images (resolution, 1280 x 1024 pixels). The images, which are considered to range from 768 x 512 to 768 x 1024 pixels, were immediately reviewed on the 2 x 3 cm camera screen, and additional pictures were taken if necessary. An overlay grid was placed next to many lesions, allowing direct measurement of dimensions. The images were immediately transmitted to many lesions, allowing direct measurement of dimensions. The images were immediately transmitted to a computer using a 3 x 2.8 autofocus zoom lens (local lengths, 36-110 mm).

The first image captured the head and upper trunk. This was followed by an image of the affected body part. Close-up images, using the maximum zoom feature of the camera and the macro lens, were then obtained. The images were immediately reviewed on the 2 x 3 cm camera screen, and additional pictures were taken if necessary. An overlay grid was placed next to many lesions, allowing direct measurement of dimensions. The average number of photographs per patient was approximately 4.5. The median was 4. The images were stored in a compressed (4:1) Joint Photographic Experts Group (JPEG) format.

For each consultation, the image and a clinical history were forwarded to a dermatologist (F.C.L.), who is in private practice, within 1 month. The dermatologist reviewed the case, and a decision was made regarding the diagnosis, differential diagnosis, and whether a biopsy was indicated. Then the dermatologist opened a sealed envelope containing the SAF teledermatologist’s triage decision. A biopsy was performed at that visit by the FTF dermatologist if the FTF dermatologist or the SAF teledermatologist favored biopsy of the lesion.

Confidence intervals (CIs) for sensitivity and specificity of the teledermatologist’s biopsy decision were based on the binomial distribution. The k statistic and its SE were generated using standard formulas.13

The total time spent per patient by the PCP with the evaluation, photography, downloading, provision of a history, and transmission of the consultation findings was initially 30 minutes; this decreased to 20 minutes after the initial patients had been enrolled. Patients underwent evaluation by the teledermatologist within 7 days of the PCP visit.

Sixty-one subjects (including 33 men) were enrolled. Of these, 49 completed the study, whereas 11 breached the study protocol and were not included in the analysis. Of the latter 11, 4 failed to present to the FTF dermatologist, 4 saw a different FTF dermatologist, 1 died of unrelated causes before seeing the FTF dermatologist, and 2 underwent evaluation of different lesions by the SAF teledermatologist and FTF dermatologist. The experience with the latter 2 patients underscores the need for rigorous photography standardization protocols that ensure accurate identification and orientation of target lesions.

Biopsies were performed in 26 of the 49 patients who underwent evaluation (Figure). In 23 cases, these biopsies were physician driven, with the remaining 3 being patient driven. For 1 patient, the FTF dermatologist and SAF teledermatologist voted to perform the biopsy, but the FTF dermatologist deemed the lesion in question to be too large for an office biopsy and referred the patient to a surgeon for this purpose. The patient failed to undergo biopsy and was lost to follow-up.

There was 100% agreement between the FTF dermatologist and the SAF teledermatologist regarding the need for a skin biopsy in the 49 cases with evaluable data. As such, the sensitivity of the SAF consultation was 1.00 (95% CI, 0.87-1.00) and specificity was also 1.00 (95% CI, 0.85-1.00). The agreement between the 2 dermatologists (k) was 1.00 (95% CI, 0.72-1.00).

Most patients underwent evaluation by the teledermatologist within 7 days of the PCP visit. The longest interval was 16 days. By contrast, the average time to see the FTF dermatologist was approximately 1 month. Four patients waited 8 to 10 weeks for the FTF dermatology visit, due to scheduling difficulties.
A remarkable 100% agreement in treatment plan was observed between the FTF dermatologist and SAF teledermatologist in their decision on whether or not to perform a biopsy (24 and 25 cases, respectively) of skin growths, which included melanocytic lesions and other types of skin neoplasms. Of the growths that underwent biopsy, 5 specimens showed basal cell carcinoma, 4 showed squamous cell carcinoma, and none were melanoma (Figure). Of the benign neoplasms deemed to be concerning enough clinically to undergo biopsy, 6 were melanocytic lesions, 2 (a dermatofibroma and a seborrheic keratosis) were pigmented lesions, 2 were dark vascular lesions, 3 were squamous cell carcinoma simulants (1 lichenoid keratosis and 2 actinic keratoses), and 1 was a neurofibroma.

The participating consultants exhibited excellent agreement on diagnosis and treatment in a presudy test of representative cutaneous conditions. In choosing these experienced clinicians, the study protocol attempted to control for differences in interobserver experience when measuring biopsy decisions between the FTF dermatologist and SAF teledermatologist.

A previous study examining biopsy recommendations for possible skin cancers (in 13 skin lesions) found 90% to 100% agreement between 2 FTF dermatologists and 2 SAF teledermatologists. However, no biopsies were performed, and the FTF dermatologists obtained the photographs and the clinical history. Zelickson and Homan demonstrated high rates of agreement in treatment plans (70%-90%) between FTF dermatologists and teledermatologists at a nursing home. No biopsy data were recorded, and consultations were not limited to growths. Another study examined medical therapy, clinic-based therapy, and diagnostic testing recommendations as a group for a wide variety of dermatologic conditions, not just growths. The authors concluded that agreement in unspecified diagnostic testing recommendations between clinician-based dermatologists and digital-image consultants was unreliable.

Cutaneous malignancies, especially malignant melanoma, are of particular concern in the primary care setting. Controversy exists regarding the applicability of SAF teledermatology for these lesions. In a study of 30 SAF consultations by Tait and Clay, a lesion in 1 patient was initially deemed by the teledermatologist to be a dysplastic nevus, and later diagnosed as a melanoma arising in a dysplastic nevus by the FTF dermatologist (who was the same person). Histopathologic confirmation of the latter diagnosis was not reported. That study concluded that SAF technology is not appropriate for the evaluation of pigmented lesions.

Our study suggests that SAF teledermatology is efficacious for the evaluation and triage of cutaneous growths. Regardless of diagnostic agreement rates, the FTF dermatologist and SAF teledermatologist concurred on the critical question of whether a biopsy was warranted. As such, the present study is in agreement with and demonstrates even more promising results than an earlier study comparing videoconferencing teledermatology with FTF dermatology in 51 patients. In that study, a dermatologist performing a skin-screening examination selected lesions for evaluation by the teledermatologist. Most of the selected lesions were regarded to be benign by both examiners and not in need of a biopsy. Under these more artificial conditions, the sensitivity and specificity of agreement on biopsy triage decisions between the FTF dermatologist and remote videoconferencing teledermatologist were 0.82 (95% CI, 0.48-98.0) and 0.87 (95% CI, 0.78-93.0), respectively. The authors concluded that although videoconferencing teledermatology may be associated with greater diagnostic uncertainty in some patients, it provided sufficient clinical information for accurate biopsy triage decisions.

Surveys have shown that physicians believe that the ultimate applicability and utility of teledermatology hinges on whether it can effectively be integrated into real-life settings, such as in a busy primary care office, without the aid of additional personnel (eg, a medical photographer), facilities (eg, a dedicated telemedicine suite), and extensive technical training. The present study directly addresses this issue by demonstrating that biopsy triage decisions may be managed effectively through SAF teledermatology in a real-time primary care setting without such infrastructure expenses.

Real-time teledermatology consultations have been shown to provide a cost savings to patients. Store-and-forward consultations, such as those performed in our study, are likely even more cost-effective for the health care system overall, as they use less expensive technology and are more efficient than real-time consultations.

An average teledermatology fee is $38 per consultation (Hon S. Pak, MD, written communication, December 21, 2002), independent of the cost of a subsequent dermatology office visit, if deemed necessary. This is less than the cost of a level 2 in-person consultation ($93.09). Other costs of teledermatology include hardware, software, office space, training of personnel, and time spent taking, uploading, and downloading photographs and sending and receiving e-mails. Hardware costs are relatively low, as digital cameras with superior specifications to the one used in this study now retail for approximately $150. As in our study, most physicians’ offices are already equipped with computers and high-speed Internet access. These costs, already part of most practice expenses, are $700 for a computer and approximately $55 per month for high-speed Internet access. Dedicated office space was not required in our protocol, and training of physicians and office staff would fill no more than 1 in-service session, if needed. The PCP spent 20 minutes per teledermatology patient, with 5 minutes devoted to obtaining a history, 7 minutes to photographing, 3 minutes to downloading images onto a personal computer, and 5 minutes to reviewing the photographs and creating an e-mail. As familiarity with the system increases, and more efficient systems are developed, this time will undoubtedly decrease.

Teledermatology is cost-effective. A significant percentage of patients (>50% in our study) ordinarily requiring an in-person dermatology consultation no longer require such a visit because of the availability of teledermatology consultation. Travel costs and time away from work and family are eliminated. Furthermore, if the SAF dermatologist determines that a biopsy is required for a growth, then the appointment with the FTF dermatologist...
may prove to be less time intensive and less expensive. If the procedural appointment is scheduled with the SAF teledermatologist, the evaluation is completed and paid for, and only a shortened appointment for biopsy is required.

The cost-effectiveness of a teledermatology system increases with the volume of teledermatology consultations, making any fixed start-up costs of the system of marginal significance. The number of teledermatology consultations requested by the PCPs may decrease as their skill to triage for dermatology consultation improves over time; this trend has been demonstrated in 1 study.26 Finally, the efficiency of the system will improve with practice and time, making up for the loss of traditional appointments as health care staff become familiar with the implementation of the technology.

Wait time for dermatology consultation using SAF technology decreases. In our study, the average wait time for a teledermatology consultation was 1 week, compared with an average wait time of 1 month for the FTF dermatologist. This compares favorably with the current average wait times for new patient appointments, estimated to be 33 days by a nationwide survey of 100 randomly selected members of the American Academy of Dermatology12 and 35 days by the American Academy of Dermatology Association’s Dermatology Practice Profile Survey 2002, which received more than 1400 member responses (available from the American Academy of Dermatology, Schaumburg, Ill). With multiple SAF dermatologists providing daily coverage, the wait time would most likely be 24 hours for consultation if this SAF technology were applied to a fee-for-service setting. A shortened time to evaluation saves patients the worry associated with a prolonged wait for an appointment for a growth that may be malignant.

In our study, teledermatology obviated a need for an FTF dermatology visit in 51% of cases, used a system that has relatively low start-up costs, and had total agreement with diagnostic recommendations of an FTF dermatologist; however, it also was relatively time intensive for the primary care provider, and photography had to be repeated for 1 of the 49 subjects. Although the performance of teledermatology systems may vary in larger groups of physicians and patients, teledermatology consultation systems that triage the need for in-person dermatology referrals may offer significant cost savings to a health care system that in 1997 saw more than 60 million skin-related visits to all physicians, including 21 million to dermatologists30; the latter figure rose to greater than 34 million by the year 2000.31 Our study suggests that the accuracy and cost-effectiveness of teledermatology to triage in-person referrals to dermatologists should be studied in a larger population of physicians and patients.

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REFERENCES