
Impact of store-and-forward (SAF) teledermatology on outpatient dermatologic care: A prospective study in an underserved urban primary care setting

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Background: The clinical value of teledermatology in the primary care setting remains relatively unknown.

Objective: We sought to determine the impact of teledermatology on outpatient diagnosis, management, and access to dermatologic care in a resource-poor primary care setting.

Methods: We performed a prospective study of store-and-forward teledermatology consults submitted between January and November 2013 from 11 underserved clinics in Philadelphia to the University of Pennsylvania using mobile devices and the Internet. We assessed diagnostic and management concordance between primary care providers and dermatologists, time to consult completion, anticipated level of dermatology input in the absence of teledermatology, and number of consults managed with teledermatology alone.

Results: The study included 196 consults encompassing 206 dermatologic conditions. Diagnoses and management plans of primary care providers and dermatologists were fully concordant for 22% and 23% of conditions, respectively. The median time to consult completion was 14 (interquartile range 3-28) hours. At least 61% of consults would not otherwise have received dermatology input, and 77% of consults were managed with teledermatology alone.

Limitations: Lack of a diagnostic gold standard, limited patient follow-up, and uncertain generalizability are limitations.

Conclusion: Teledermatology is an innovative and impactful modality for delivering dermatologic care to outpatients in resource-poor primary care settings. (J Am Acad Dermatol 2016;74:484-90.)

Key words: health care access; mobile; outpatient dermatology consultation; store-and-forward; technology; teledermatology; telemedicine.

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Telemedicine is an established modality to provide dermatologic care.^{1,2} Real-time or live interactive teledermatology uses video conferencing to transfer information across distance, whereas store-and-forward (SAF) teledermatology uses still digital images to transfer information across distance and time. The shortage of dermatologic services in the United States has resulted in lengthy wait times for in-person evaluations,³⁻⁵ a challenge exacerbated for Medicaid and uninsured patients⁶⁻⁸ and patients in rural areas.^{4,5} Teledermatology has been shown to be cost-effective in certain settings and to decrease wait times and in-person referrals.⁹⁻²⁰

Multiple studies have compared teledermatology with conventional clinic-based consultation, including randomized trials demonstrating equivalent or favorable clinical outcomes for SAF teledermatology.^{15,21-23} With the advancement of mobile technologies, researchers have determined the feasibility and diagnostic accuracy of teledermatology using platforms such as smartphones.²⁴⁻²⁸ Despite the rapid expansion of the teledermatology literature, relatively few studies have compared teledermatology with care provided by nondermatologists.²⁸⁻³⁹

The purpose of this study was to determine the impact of SAF teledermatology on the delivery of dermatologic care to outpatients in underserved primary care clinics in Philadelphia, PA. Specifically, we sought to measure diagnostic and management concordance between primary care providers (PCPs) and dermatologists, time to consult completion, anticipated level of dermatology input in the absence of teledermatology, and number of consults managed with teledermatology alone.

METHODS

Study design and participant protection

We performed a prospective study between January and November 2013. The study was approved by the Philadelphia FIGHT, Philadelphia Department of Public Health (PDPH), and University of Pennsylvania institutional review boards and the Dr Bennett L. Johnson Jr Sayre Health Center community research review committee. Verbal informed consent and Health Insurance Portability

and Accountability Act authorization were obtained from patients; written informed consent was obtained from providers. No patient identifiers were requested.

Setting and participants

SAF teledermatology consults were submitted to dermatologists at the University of Pennsylvania by PCPs from the Jonathan Lax, Sayre Health, and 9 PDPH centers, all of which provide health care to underserved populations. The Jonathan Lax Center focuses on the primary care of HIV-positive patients and PDPH Health Center 1 focuses on the treatment of sexually transmitted diseases. According to a PDPH report, the average household poverty rate across the health center service areas was 28.7%, the rate of uninsured was 11.7%, and the rate

without a regular source of health care was 10.8%. These were higher than the corresponding rates in the general Philadelphia population (18.4%, 10.6%, and 10.4%, respectively).⁴⁰

Teledermatology platform and consultation process

Teledermatology consults were handled using the AccessDerm (Vignet Corporation, Fairfax, VA) mobile SAF platform.⁴¹ This volunteer service, developed by the American Academy of Dermatology (AAD) to reach underserved populations in the United States,⁴² has provided over 1000 consults.⁴¹ It is available through an application for Google Android cellular telephones (HTC Corporation, New Taipei City, Taiwan) and iPhones and iPads (Apple Corporation, Cupertino, CA), and a World Wide Web–based interface (<https://accessderm.aad.org>).

PCPs were advised to submit cases for teledermatology consultation that they thought would benefit from a dermatologist's input. The 16-item AccessDerm (Vignet Corporation) questionnaire (Supplementary Table I; available at <http://www.jaad.org>) requested patient age, sex, and focused dermatologic history. PCPs were required to provide a diagnosis and treatment plan, and specify the type of care that the patient would have received in the absence of teledermatology. PCPs uploaded

CAPSULE SUMMARY

- The impact of teledermatology in the primary care setting remains relatively unevaluated.
- There was full diagnostic and management concordance between primary care providers and dermatologists for 22% and 23% of dermatologic conditions, respectively. Teledermatology increased consultation speed and accessibility.
- These findings support the value of teledermatology for underserved urban patients.

Abbreviations used:

| | |
|-------|--|
| AAD: | American Academy of Dermatology |
| PCP: | primary care provider |
| PDPH: | Philadelphia Department of Public Health |
| SAF: | store-and-forward |

photographs obtained with either a personal mobile device camera or a 16.1-megapixel autofocus digital camera (Canon Corporation, Tokyo, Japan) configured at 2 megapixels. PCPs were encouraged to update consults with clinical outcomes; however, this information was not regularly recorded. Dermatologists responded to consults by providing a differential diagnosis, treatment plan, and recommendation for or against in-person evaluation. If recommended, patients were offered a visit with a dermatologist at the University of Pennsylvania. For uninsured patients, the visit and any necessary skin biopsies were provided free-of-charge.

All AccessDerm data were encrypted, authenticated, and securely transmitted to a server maintained by the Vignet Corporation on behalf of the AAD in accordance with Health Insurance Portability and Accountability Act regulations. Data on enrolled patients were abstracted into a database for analysis.

Outcome measures

For each dermatologic condition, 2 investigators (C. A. N. and J. T.) independently reviewed the differential diagnoses and management plans of the PCP and dermatologist and determined diagnostic and management concordance according to the coding system shown in [Table I](#). Changes in management were categorized as medication initiation or discontinuation, change in medication dosage or vehicle, recommendation for laboratory testing, recommendation for procedural intervention, or recommendation for education or observation (adapted from Lamel et al³⁶). Given the subjectivity involved in identifying clinically significant educational recommendations, an analysis excluding these changes was also performed. Interrater reliability as measured by Cohen kappa coefficient for diagnostic and management concordance between the 2 investigators was 0.86 (95% confidence interval 0.83-0.89) and 0.86 (95% confidence interval 0.81-0.90), respectively. Disagreements were resolved via adjudication by a third investigator (K. A. W.).

Time to consult completion, anticipated level of dermatology input in the absence of teledermatology, and consult management with teledermatology

alone served as measures of impact on access to dermatologic care. Time to consult completion was defined by the duration between the initial consult (including photographs) and dermatologist response. Anticipated level of dermatology input was based on PCP response to the question, "In the absence of this teledermatology service, how would this patient have otherwise received care for this condition?" A determination of "no input" was made if the PCP checked "I would take care of the issue myself" or "patient would not have received care"; "in-person referral" if the PCP checked "in-person dermatologist referral"; or "unknown" if the PCP checked "urgent care or emergency room" or "other" without specification. PCPs checked multiple options for 8 consults: a determination of dermatology input was made jointly by 2 investigators (C. A. N. and J. T.). Consult management by teledermatology alone was based on the initial recommendation of the dermatologist for or against in-person evaluation.

Statistical analysis

All data were summarized with descriptive statistics. Interrater reliability was assessed for diagnostic and management concordance using Cohen kappa coefficient. Statistical analyses were performed with software (Stata 12.1, StatCorp LP, College Station, TX).

RESULTS

Study enrollment

Nine board-certified dermatologists responded to 225 consults submitted by 30 PCPs. Twenty-nine consults were excluded for the following reasons: 22 were excluded by the PCP either because the patient declined to provide informed consent and Health Insurance Portability and Accountability Act authorization (4) or for an unspecified reason (18), 6 were submitted without photographs, and 1 was submitted on a prisoner. The remaining 196 consults encompassed 206 dermatologic conditions. [Table II](#) summarizes consult characteristics and [Table III](#) shows the distribution of diagnostic categories.

Impact on diagnosis and management

Evaluation of diagnostic concordance revealed partial or complete discordance for the majority of dermatologic conditions as follows: 46 (22%) concordant, 65 (32%) partially concordant level I, 29 (14%) partially concordant level II, and 65 (32%) discordant. Evaluation of management concordance revealed a similar pattern: 47 (23%) concordant, 39 (19%) partially concordant level I, 31 (15%) partially

Table I. Concordance coding system

| Diagnostic concordance | Management concordance |
|--|---|
| Concordant: Full agreement | Concordant: Full agreement |
| Partially concordant level I: Agreement between at least 1 but not all diagnoses | Partially concordant level I: Partial agreement with 1 category of change [†] only |
| Partially concordant level II: Agreement between diagnostic categories* only | Partially concordant level II: Partial agreement with >1 category of change [†] |
| Discordant: No agreement or PCP unable to provide a differential diagnosis | Discordant: No agreement or PCP unable to provide a management plan |
| Indeterminate: Dermatologist unable to provide a differential diagnosis | Indeterminate: Dermatologist unable to provide a management plan |

PCP, Primary care provider.

*Diagnostic categories, determined based on the leading diagnosis of the dermatologist or the definitive diagnosis when available, were acneiform/follicular occlusion disorders, benign tumors/proliferations, eczematous conditions, infectious diseases, papulosquamous conditions, pigmented lesions, premalignant/malignant lesions, and other.

[†]Categories of change in management were medication initiation or discontinuation, change in medication dosage or vehicle, recommendation for laboratory testing, recommendation for procedural intervention, or recommendation for education or observation.

Table II. Consult characteristics

| Characteristic | N = 196 |
|------------------------------------|------------|
| Age, y | |
| Median (IQR) | 39 (26-50) |
| Sex, No. (%) | |
| Male | 101 (52) |
| Female | 93 (47) |
| Unknown | 2 (1) |
| Consults per primary care clinic | |
| Median (IQR) | 19 (5-30) |
| Consults per primary care provider | |
| Median (IQR) | 6 (2-9) |
| Consults per dermatologist | |
| Median (IQR) | 17 (11-32) |

IQR, Interquartile range.

concordant level II, and 80 (39%) discordant (Fig 1). A differential diagnosis and management plan could not be provided via teledermatology for 1 (<1%) and 9 (4%) conditions, respectively.

The distribution of categories of change in management for the 150 dermatologic conditions with partial or complete management discordance is shown in Table IV. Recommendation for education or observation was the most common category, occurring in 95 (63%) conditions, followed by medication initiation or discontinuation in 84 (56%), recommendation for laboratory testing in 28 (19%), recommendation for procedural intervention in 14 (9%), and change in medication dosage or vehicle in 7 (5%). Exclusion of educational recommendations resulted in an increase in concordance and partial concordance level I to 63 (31%) and 47 (23%), respectively, a decrease in partial concordance level II to 7 (3%), and no change in discordance.

Table III. Diagnostic categories

| Category, no. (%) | N = 206 |
|--|---------|
| Eczematous conditions | 63 (31) |
| Infectious diseases | 29 (14) |
| Benign tumors/proliferations | 18 (9) |
| Papulosquamous conditions | 15 (7) |
| Pigmented disorders | 11 (5) |
| Premalignant/malignant lesions | 11 (5) |
| Acneiform/follicular occlusion disorders | 8 (4) |
| Other* | 47 (23) |
| Indeterminate | 4 (2) |

*The most common diagnoses (in descending order) were: 24 (12%) cutaneous reactions to arthropod bites, 17 (8%) adverse cutaneous drug reactions, 6 (3%) sarcoidosis, 5 (2%) lupus erythematosus, and 5 (2%) prurigo.

Impact on access to dermatologic care

The median (interquartile range) time to consult completion was 14 (range 3-28) hours. When night (5 PM to 8 AM), weekend, and US federal holiday hours were excluded, the median time to consult completion was 4 (interquartile range 1-9) hours. In all, 120 (61%) consults would not have received dermatology input in the absence of teledermatology, whereas 63 (32%) consults would have received in-person referrals (Fig 2, A). Anticipated level of dermatology input could not be determined in 13 (7%) consults, 11 (85%) of which would have been referred to an urgent care center or emergency department.

In all, 150 (77%) consults were managed by teledermatology alone. When stratified by anticipated level of dermatology input in the absence of teledermatology, the majority remained manageable by teledermatology alone (Fig 2, B). Recommendation for in-person dermatology

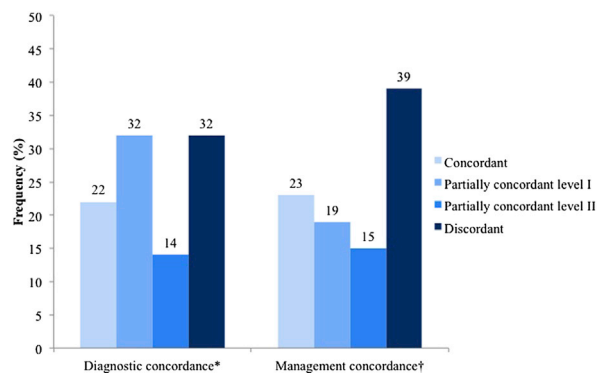


Fig 1. Diagnostic and management concordance between primary care providers and dermatologists. *A differential diagnosis could not be provided via teledermatology for <1% of dermatologic conditions. †A management plan could not be provided via teledermatology for 4% of dermatologic conditions.

Table IV. Categories of change in management

| Category, no. (%) | N = 150 |
|---|---------|
| Recommendation for education or observation | 95 (63) |
| Medication initiation or discontinuation | 84 (56) |
| Recommendation for laboratory testing | 28 (19) |
| Recommendation for procedural intervention* | 14 (9) |
| Change in medication dosage or vehicle† | 7 (5) |

*Recommendations for procedural intervention included biopsy, cryotherapy, electrodesiccation and curettage, and excision.

†All changes in medication dosage or vehicle pertained to topical steroids.

evaluation occurred in 15 (13%) consults that would not otherwise have received dermatology input; whereas 37 (59%) consults that would otherwise have been referred to an in-person dermatologist were definitively managed with teledermatology. Eight (62%) consults in the unknown category were definitively managed with teledermatology, including 6 of the 11 consults that would have been referred to an urgent care center or emergency department.

DISCUSSION

Our study suggests that teledermatology enhances the delivery of outpatient dermatologic care in the primary care setting. There was partial or complete diagnostic discordance between PCPs and dermatologists for 78% of dermatologic conditions. Because changes in management are likely to have the highest impact on clinical outcomes, the observation of partial or complete discordance for 73% of conditions is particularly significant. Most changes were consistent with recommendations for education or observation or medication

initiation or discontinuation. Excluding educational recommendations, management for the majority (65%) of conditions remained partially or completely discordant.

Comparison of these results with prior research is limited by availability of data and heterogeneity of study design. SAF teledermatology studies have reported varied diagnostic discordance between PCPs and dermatologists from 39% to 67%.^{29,30,32,34,35,39} Greisman et al²⁸ reported diagnostic and management changes between medical students submitting SAF teledermatology consults on behalf of PCPs and a dermatology resident with attending supervision in 55.9% and 89.2% of cases, respectively. Chen et al³¹ reported partial or complete discordance in diagnosis and management between PCPs and dermatologists participating in pediatric SAF teledermatology as 52% and 72%, respectively. For live interactive teledermatology, Lamel et al³⁶ reported changes in the diagnosis and management plan of the PCP in 69.9% and 97.7% of cases, respectively, whereas Al Quran et al³⁸ reported such changes in 19% and 9% of cases, respectively. Multivariable analyses by Lamel et al³⁶ revealed significant associations between these changes and improvement in clinical outcomes.

Our study furthermore suggests that teledermatology increases the speed and accessibility of dermatologic consultation. The median time to consult completion of 14 hours or 4 hours excluding night, weekend, and holiday hours is consistent with that previously reported.^{17,20} These times are considerably shorter than wait times for new in-person dermatology evaluations.^{4,5} Teledermatology provided access to dermatologic care for at least 61% of consults that would not otherwise have received dermatology input. One of these consults detected melanoma on an uninsured patient who received curative therapy. Management of 77% of consults with teledermatology alone enabled a net reduction of 22 (35%) in-person dermatology referrals and 6 (55%) urgent care center or emergency department referrals. This supports the use of teledermatology in unburdening overstretched health care resources.^{9,10,15,17,19,20}

These results should be interpreted in light of several limitations. First, definitive diagnoses were available for only 8 (4%) conditions; therefore, the dermatologists' initial diagnoses served as the gold standard in the determination of diagnostic concordance. Second, our data may not be generalizable to high-resource settings or resource-poor settings in which in-person dermatologist evaluations and biopsies are not available to uninsured patients free-of-charge. Finally, limited

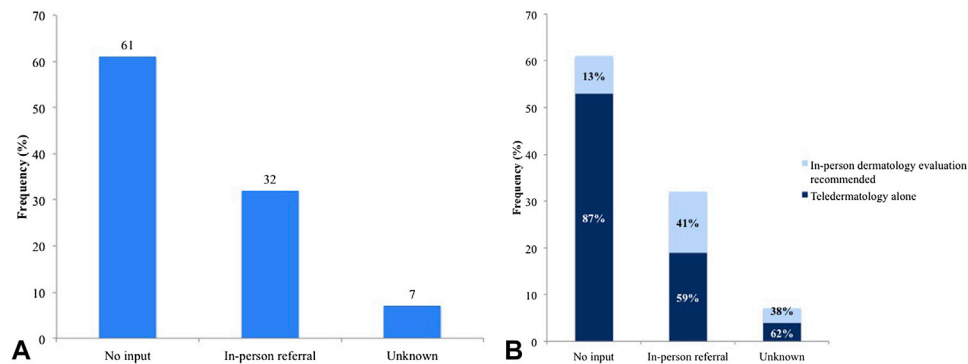


Fig 2. A, Anticipated level of dermatology input in the absence of teledermatology. **B,** Consult management with teledermatology stratified by anticipated level of dermatology input in the absence of teledermatology.

patient follow-up prevented the collection of sufficient data to directly determine the impact of teledermatology on clinical outcomes. Further studies are essential to investigate this question, particularly for pigmented neoplasms.^{27,43-45}

In conclusion, the high proportions of diagnostic and management discordance observed between PCPs and dermatologists in this study support the potential of SAF teledermatology to improve not only access to outpatient dermatologic care, but also clinical outcomes in the primary care setting. We anticipate that further dissemination of existing technologies and the development of novel technologies will enhance the feasibility of teledermatology. Continued research is important to explore the benefits and limitations of teledermatology and guide future efforts to connect dermatologists with patients in need of care.

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Supplementary Table I. AccessDerm* questionnaire

| Question | Answer format |
|---|---|
| Please enter a title for the case (eg, "rash on left hand") [†] | Free response |
| Age of the patient | Free response |
| Gender | Male or female |
| How long has the patient had this condition? | Free response |
| What are the symptoms of this condition? | Free response |
| Does anyone in the family have a similar condition? | Free response |
| Where on the body did the rash/lesion first appear? | Free response |
| Which areas of the skin are currently involved? | Free response |
| Does anything make the skin problem worse? | Yes (free response) or No |
| Does anything make the skin problem better? | Yes (free response) or No |
| Has the rash been treated with anything? | Yes (free response) or No |
| What other medications is the patient taking? | Free response |
| Please list any relevant medical history | Free response |
| What do you think is the most likely diagnosis? [†] | Free response |
| What is the treatment plan for the patient? [†] | Free response |
| Please list when the patient will be seen in follow-up in your clinic | Free response |
| In the absence of this teledermatology service, how would this patient have otherwise received care for this condition? (Check all that apply) [†] | I would take care of the issue myself; Urgent care or emergency room; In-person dermatologist referral; Patient would not have received care; and/or Other (please specify) (free response) |
| Additional comments | Free response |
| Consent has been signed by the patient? [†] | Yes or No |

*Vignet Corporation, Fairfax, VA.

[†]Required questions.