Improving Access to Care Through the Establishment of a Local, Teledermatology Network

Collin M. Costello, MD,[1] Helen J.L. Cumsky, MD,[1] Connor J. Maly, BS,[1,2] Jamison A. Harvey, MD,[1] Matthew R. Buras, MS,[3] Peter J. Pallagi, BFA,[4] Anna L. Gustaveson, PA-C,[5] Davinder P. Singh, MD,[5] Steven A. Nelson, MD,[1] Mark R. Pittelkow, MD,[1] and Aaron R. Mangold, MD[1]

[1]*Department of Dermatology, Mayo Clinic, Scottsdale, Arizona, USA.*
[2]*Georgetown School of Medicine, Washington, District of Columbia, USA.*
[3]*Department of Health Science Research, Mayo Clinic, Scottsdale, Arizona, USA.*
[4]*Department of Media Support, Mayo Clinic, Scottsdale, Arizona, USA.*
[5]*Mountain Park Health Center, Phoenix, Arizona, USA.*

Abstract

Introduction: *Access to dermatologic care is a major issue in the United States, especially within the un- and underinsured populations; technology, including teledermatology, will pay a role in improving access to care.*

Methods: *We performed a prospective study between November 2016 and September 2017. We leveraged a partnership between Mayo Clinic and Mountain Park Health Clinic, a community clinic that primarily serves un- and underinsured populations. We implemented a mobile phone-based store and forward (SAF) teledermatology service, which integrated an external community health clinic to an existing electronic health record (EHR) using standardized data capture forms, real-time support, and simple workflows.*

Results: *Thirty-seven patients were enrolled in the study, 65% female and 35% male with an average age of 47.9 (SD = 15.9). The ethnic breakdown was: 81.1% Hispanic, 13.5% Caucasian, and 5.4% African American. The majority, 62.2%, did not have a high school education, 45.9% were unemployed, and 51.4% were uninsured. 64.9% earned less than $25,000 for annual household income. Teledermatology consultation increased the absolute diagnostic and management concordance by 36.6% (*$p = 0.01$*, 95% CI 12.2%–61.0%) and 34.2% (*$p < 0.01$*, 95% CI 11%–57%), respectively. Primary care providers had a significant increase in mean confidence in the diagnosis and management of dermatology conditions pre and poststudy (3.60 vs. 3.70 and 3.21 vs. 3.60, respectively;* $p < 0.01$*). Ninety-six percent of the primary care providers agreed (52.0%) and strongly agreed (44.0%) that they would send another patient for teleconsultation.*

Conclusion: *We successfully implemented a SAF teledermatology consultative service in a community health clinic outside our EHR. A similar approach can be used by other large health care organizations to provide integrated, high-quality consultation to clinics with rural, un- and underinsured populations.*

Keywords: *telemedicine, teledermatology, dermatology, education*

Introduction

Access to dermatologic care is a major issue in the United States. With a growing and aging population, there will be an increasing demand for dermatologic care. The growth in dermatologic disease burden has not been met by an increased provider workforce and the average wait times are 30 days.[1,2] There are disparities in the distribution of dermatologists especially in rural and lower-income communities.[1] Medicaid-insured and uninsured patients make up 5% of patients in dermatology practices, while they account for 27% of the U.S. population.[3,4] Significant patient and provider barriers lead to such disparities. Teledermatology and telereferral networks represent a novel modality to bridge these gaps.

Teledermatology is an effective and reliable mechanism to provide high-quality as well as cost- and time-effective care for underserved communities.[5,6] The American Academy of Dermatology's AccessDerm application and expanded institutional electronic health records (EHRs) were successful in improving access, providing care, and reducing wait times in the underserved.[6–9] To date, no groups have established teledermatology services in community health clinics that integrate into an established EHR system. As such, large institutions are less inclined to provide teleconsultative care outside of the institutions' network. We aimed to establish a local teledermatology network to

provide care for disparate groups falling outside of the current teledermatology safety net.

A recent knowledge-based survey study found that primary care providers (PCPs) using teledermatology had higher scores over time.[10] This effect was more pronounced with increased utilization of teledermatology services. Despite these findings, no groups have created a needs-based, education program for PCPs participating in teledermatology consultations. We believe that integrated teledermatology platforms will encourage care for the underserved and that appropriate education for PCPs will improve the teleconsultative process and reduce the need for face-to-face visits. We performed a pilot study using a mobile phone-based store and forward (SAF) teledermatology service and a needs-based education program in a community health clinic. Our objective was to create and optimize a scalable teledermatology program for community health clinics.

Methods

This study was approved by the Mayo Clinic Institutional Review Board. We performed a 10-month, prospective study between November 2016 and September 2017 at Mountain Park Health Clinic (MPHC), which serves the underinsured patient population in Phoenix, Arizona. Creating a local teledermatology network can be broken down into three phases: preimplementation, implementation, and maintenance.

PREIMPLEMENTATION, IMPLEMENTATION, AND MAINTENANCE

To identify a community partner, we used community health needs assessment surveys and presented our pilot project to community stakeholders. We began working directly with MPHC to identify PCPs and establish technological obstacles, expected volumes, workflows for providers (*Supplementary Fig. S1*), and contingency plans for technological failures. Pilot PCPs were selected based upon interest. Each PCP was trained on their workflow and practiced with mock consultations. The allied supportive staff were trained on their workflow, their PCPs' workflow, and performed mock consultations. Both PCPs and allied staff were trained on how to capture high-quality images. This includes taking a photo for reference, a close-up photo, and a dermoscopic photo. Education on proper lighting was provided as well as instructions to take an additional photo from the side for exophytic lesions.

Mobile devices with dermoscopic attachments, Dermlite DL4 (3Gen), were used for image acquisition. A virtual private network (VPN), the Mayo Clinic PhotoExam application, and HIPAA-compliant/encrypted Qualtrics standardized templates were used to transmit all information. The PhotoExam application was designed by Mayo Clinic to allow photographs taken with mobile devices to be directly loaded into the patients' EHR. Standardized data capture forms were used for lesional or rash history summarized by PCPs, teledermatology consultation, postteledermatology consultation primary care plan, face-to-face dermatology consultation, and post-face-to-face provider discussions.[11] All documents were recorded using digital templates on Apple iPads and were stored in a Qualtrics database. When a teleconsultation was performed, an e-mail was automatically sent through Qualtrics to the registration department to ensure the patient was assigned a medical record number (MRN). All linked clinical information was sent automatically through protected e-mail to the teledermatologist. Once the patient received an MRN, the photographs that were submitted through the PhotoExam were automatically added to the patients' charts on Powerchart by Cerner. Clinical notes were communicated back to the PCP from the teledermatologist by either fax or encrypted e-mail depending on the PCPs' preference.

During the first several weeks of implementation, we provided onsite assistance two half-days per week. During this time, workflows and photography were optimized. After several weeks of optimization, support staff was available through cellular phone. Weekly follow-up e-mails were sent to all participating staff to outline the weeks' consultations providing both positive feedback and constructive criticism.

EDUCATIONAL PROGRAM

A mixed-method, cross-sectional study design approach was used, including quantitative and qualitative assessments with active input from community-based PCPs. Knowledge, confidence in the diagnosis, and management of dermatologic diseases were determined with qualitative and quantitative surveys. Assessments were performed to evaluate each participating PCP for their level of baseline knowledge, confidence in diagnosis, and confidence in the management of dermatologic diseases organized by specific diagnostic categories (*Table 1*). Based upon our assessments, six 1-h monthly education sessions were given on the "Top 10 most common and most difficult diagnoses." In addition, each PCP received educational feedback with each teleconsultation. Pre- and posteducation assessments of the level of knowledge, confidence in the diagnosis, and management of dermatologic diseases were performed.

DATA COLLECTION

Measurements of satisfaction, confidence, and accuracy were performed pre- and postconsultation for reach referral. Efficiency and efficacy of referrals were determined by the

Table 1. Diagnostic Categories and Subcategories

CATEGORY	SUBCATEGORIES
Acneiform	Acne, Rosacea
Benign	Nevi, Neurofibroma, Dermatofibroma, Seborrheic Keratosis, Epidermal Cyst
Dermatitis	Allergic, Contact, Irritant, Asteatotic, Atopic
Fungal	Tinea Corpis, Tinea Pedis, Tinea Capitis, Onchomycosis
Malignant	Basal, Squamous, Melanoma
Papulosquamous	Psoriasis, Seborrheic Dermatitis, Pityriasis Rosea, Lichen Planus, Lichen Sclerosis, Cutaneous lupus
Premalignant	Actinic Keratosis, Bowenoid Papulosis, Condyloma Accuminata, Oral Leukoplakia
Viral/bacterial	Verruca, Molluscum, Shingles/Zoster, Herpes Simplex, Folliculitis

rates of face-to-face consultation, wait times, diagnostic and management concordance, and PCP satisfaction. Wait time was defined from the time the PCP finished the teledermatology consult form to the time that the teledermatologist completed the consult. Business days were calculated using business hours between 8:30 AM and 5:30 PM, excluding weekends and holidays. Concordance in diagnosis and management was scored (A.R.M. and H.J.L.C.) using a prior published methodology of full concordance, partial concordance level I, partial concordance level II, discordant, and indeterminate. Full definitions are listed in *Table 2*[6]; full concordance demonstrates agreement, partial concordance demonstrates different levels of partial agreement, and discordant demonstrates no agreement between the dermatologist and PCP. Discrepant cases were resolved through a case review (A.R.M., S.A.N., and H.J.L.C.).

STATISTICAL ANALYSIS

Descriptive statistics and univariate analyses were used for the needs assessment, knowledge and confidence in diagnosis, and management of dermatologic diseases. Similar statistical analyses were performed with pre- and postconsultation satisfaction, confidence, and accuracy. Numerical variables, such as age, are summarized as mean (SD), whereas categorical variables, such as diagnostic category, are summarized by frequency (%). Missing values were excluded. Changes in diagnostic concordance or discordance between PCP and teledermatology consultation and PCP postconsult and teledermatology consultation were compared using the unpaired z-test for two-sample proportions. Ninety-five percent confidence intervals (CIs) for the differences in concordance were calculated using a normal approximation. The same approach was used for the change in management concordance and discordance. In comparing prestudy to poststudy, the change in referral rates form was assessed using the McNemar's test and the change in confidence was assessed using the Wilcoxon Signed-Rank test. All hypothesis tests were two sided and $p < 0.05$ was considered statistically significant. All analyses were performed in SAS v9.4 (SAS Institute, Cary, NC).

Results

CASES

Thirty-seven patients were enrolled in the study with 38 teleconsultations in total (1 patient seen twice). The study population was 65% female and 35% male with an average age of 47.9 (SD 15.9). The ethnic breakdown was: 81.1% Hispanic, 13.5% were non-Hispanic Caucasian, and 5.4% were African American. The majority, 62.2%, did not have a high school education, 45.9% were unemployed, and 51.4% were

Table 2. Diagnostic Concordance Definitions[a]

CONCORDANCE	DIAGNOSTIC	MANAGEMENT
Fully concordant	Full agreement between PCP and dermatologist	Full agreement between PCP and dermatologist
Partial concordance level 1	Agreement between at least 1 but not all diagnoses	Partial agreement with 1 category of change only[b]
Partial concordance level 2	Agreement between diagnostic categories only[c]	Partial agreement with >1 category of change[b]
Discordant	No agreement or PCP unable to provide a differential diagnosis	No agreement of PCP unable to provide a management plan
Indeterminate	Dermatologist unable to provide a differential diagnosis	Dermatologist unable to provide a management plan

[a]Reference.[6]

[b]Categories of change in management were medication indications or discontinuation, change in medication dosage or vehicle, recommendations for laboratory testing, recommendations for procedural interventions, or recommendations for education or observation.

[c]Diagnostic categories listed in *Table 1.*

PCP, primary care provider.

Table 3. Breakdown of Teledermatology Consults by Diagnostic Category

DIAGNOSTIC CATEGORIES, *N* (%)	*N* = 37
Benign proliferation	16 (43.2%)
Other	8 (21.6%)
Dermatitis	6 (16.2%)
Infectious	2 (5.4%)
Pigmented lesions premalignant	3 (8.1%)
Pigmented lesions malignant	1 (2.7%)
Acneiform	1 (2.7%)

uninsured. 64.9% earned less than $25,000 for annual household income.

If unable to send for an e-consult, 73.9% of PCPs would have sent for dermatology consultation. The diagnostic breakdown of referrals is shown in *Table 3*. The median wait time was 32 h (range 8–160 h; average 42 h). Diagnostic and management concordance before teledermatology consult demonstrated partial concordance and discordance for 68.4% (31.6% fully concordant, 18.4% partially concordant level 1, 28.9% partially concordant level 2, and 21.1% discordant) and 84.2% (15.8% fully concordant, 31.6% partially concordant level 1, 15.8% partially concordant level 2, and 36.8% discordant) of cases, respectively. Evaluation of diagnostic and management concordance after teledermatology consult demonstrated partial concordance and discordance for 31.7% (68.2% fully concordant, 22.7% partially concordant level 1, 4.5% partially concordant level 2, and 4.5% discordant) and 50.0% (50.0% fully concordant, 37.5% partially concordant level 1, 8.3% partially concordant level 2, and 4.2% discordant) of cases, respectively. Teledermatology consultation increased the absolute diagnostic and management concordance by 36.6% ($p = 0.01$, 95% CI 12.2%–61.0%) and 34.2% ($p < 0.01$, 95% CI 11%–57%), respectively. Teledermatology consultation significantly decreased the absolute discordance for management by 33% ($p < 0.01$, 95% CI 15%–50%); however, it did not significantly decrease the absolute discordance for diagnosis ($p = 0.08$). Nine cases (23.7%) required a face-to-face referral with a dermatologist. Of the nine cases, the diagnostic categories included three benign proliferations, two pigmented lesions, one premalignant/malignant lesion, and three other lesions. The most common reason for referral was for an advanced procedure in five of nine face-to-face referrals.

PROVIDER SATISFACTION

The majority of PCPs were satisfied with e-consults. Ninety-six percent of PCPs (agreed [56.0%] or strongly agreed [40.0%]) learned something about dermatologic diagnosis from the teleconsultation. One hundred percent of PCPs (agreed [56.0%] and strongly agreed [44.0%]) felt that the teleconsultation helped with patient care, and 96% of PCPs (agreed [52.0%] and strongly agreed [44.0%]) that they would send another patient for teleconsultation.

PRE- AND POSTSTUDY PROVIDER ANALYSIS

Five PCPs completed the prestudy and three PCPs completed the poststudy survey. The prestudy theoretical referral rate was 56.1% for all topics surveyed. The prestudy theoretical referral rates for educational topics (ET) and noneducational topics (NET) were 47.2% and 66.7%, respectively. The poststudy theoretical referral rate for all topics was 53.0%. The poststudy theoretical referral rates for ET and NET were 52.8% and 53.3%, respectively. The change in theoretical referral rates between pre- and posteducation was nonsignificant.

Overall, PCPs had a significant increase in mean confidence in the diagnosis and management of dermatology conditions pre- and poststudy (3.36 vs. 3.70 and 3.21 vs. 3.60, respectively; $p < 0.01$). There was a significant increase in mean confidence in the management of ET dermatology conditions (3.42 vs. 3.82; $p < 0.01$). However, there was not a significant increase in confidence in the diagnosis of ET (3.63 vs. 3.83; $p = 0.14$). For NET, there was a significant increase in confidence for both diagnosis and management (3.02 vs. 3.54 and 2.95 vs. 3.33, respectively; $p < 0.01$). There was no significant difference when comparing the change in confidence of diagnosis or management of ET and NET (*Supplementary Table S1*).

Discussion

Our pilot study successfully implemented a mobile phone-based SAF teledermatology service and a needs-based education program in a community health clinic. We found that teledermatology consultation increased the absolute diagnostic and management concordance by 36.6% ($p = 0.01$) and 34.2% ($p < 0.01$), respectively. PCPs found value in teleconsultations and educational sessions with an overall improvement in diagnosis and management confidence (from 3.36 to 3.70 and from 3.21 to 3.60, respectively; $p < 0.01$). PCPs were satisfied with the teleconsultation: 96% agreed that they learned about the dermatologic diagnosis with teleconsultation, 100% felt the teleconsultation helped patient care, and 96% would send another patient for teleconsultation. Taken together, this study established an approach for the implementation of community-based teledermatology services, underscores the utility of teledermatology in health care disparate populations, and shows

the importance of community engagement through targeted educational programs.

Creating a teledermatology service outside of an institutions' network is difficult and requires tremendous effort by both the dermatologists and the community providers. Successful implementation is dependent upon a deep commitment from the community providers. Teledermatology services increase the clerical burden for PCPs. Optimizing the teledermatology workflow for ease of use led to high referring provider satisfaction. Our overall satisfaction rates for PCPs was 96%–100%, which is higher than previous studies of 63%–71.4%.[12,13] Our high PCP satisfaction was likely secondary to a streamlined process with standardized data capture forms, real-time support for the providers, and simple workflows. These findings are similar to previous publications that found improved workflows, effective communication between PCPs and dermatologists, and fast turnarounds lead to high provider satisfaction.[13,14]

The successful use of SAF teledermatology is dependent upon safe, efficient, effective, and timely care. For cost-effective care, SAF teledermatology should have in-person referral rates less than 79%.[15] In-person referral rates for SAF teledermatology have been decreasing over time. In the early 2000s, the rates were 69%–82%,[15,16] whereas, recent reported rates are as low as 23%.[6] Within our study, in-person referral rates were 23.7%. Compared with prior studies, our study had similar initial diagnostic partial concordance and discordance of 68.4% versus 64.3%–78%[6,11] and a slightly higher management partial concordance and discordance of 84.2% versus 71.4%–77%.[6,11] Similar to previous reports, we found a significant decrease in partial concordance and discordance after teledermatology consultation.[11] The median time from consult to response was 32 h, which is longer than prior studies, median of 14 h to an average of 24 h.[6,9] This is due to the time required to integrate data from multiple sources into our EHR. However, a 32-h wait is significantly improved over the average 30-day wait for an in-office visit. Based upon our experience, community-based teledermatology networks provide increased access to timely, high-quality, and cost-effective care for the underserved population.

Our low referral rates in a complex patient population were likely related to PCP education. We found significant improvement in confidence of the diagnosis and management of dermatologic diseases pre- and poststudy. However, similar to prior reports, PCPs did not show any significant improvement in ET versus NET.[11] We believe that the complexity of the ET comprising diagnoses, which the PCPs were most uncomfortable with, and the real-time educational feedback with each consultation confounded our results. Future studies need to be conducted to directly evaluate didactic versus real-time education for PCP using teledermatology.

Institutions have utilized the American Academy of Dermatology's AccessDerm application to provide care to underserved populations.[6] AccessDerm is able to link local dermatologists to community providers; however, it lacks integration into an EHR system and dual documentation may discourage participation. Alternatively, institutions have developed teledermatology services for providing expanded access to community clinics within their health system.[7,8] However, such services require access to expensive EHR systems. Most community clinics fall outside of the institutions' networks. Herein, we develop an additional model that utilizes a mobile phone-based application that integrates community clinics outside of a health system into an existing EHR. This model could be implemented at other urban and rural communities.

One of the most significant barriers to our process was the use of a VPN to send directly to the EHR. This added time and step disincentivizes providers. Future studies as well as real-world implementation using products that allow for easy access to the VPN, such as Microshare, should be considered. Alternatively, the institution could install encrypted Wi-Fi routers at the community clinic. Both options have added cost, which may not be ideal for volunteer services. However, one can justify such an expense when balancing the time cost and efficiency of televolunteer services versus the inefficiencies in traditional community-based volunteer work. Another barrier was the creation of an MRN. Our request to create an MRN was automated; however, the assignment of the MRN required employees in the registration department to manually create the MRN. This workflow delayed the interpretation of e-consultations by 1–2 business days. With proper financial support, this process could be automated. Finally, our clinical information was not integrated with the clinical images. Qualtrics automatically transmitted the clinical information directly to the referring provider "on-call" through a predetermined call pool. Future development of photoexamination applications with integrated questionnaires will alleviate this issue.

We encountered significant barriers to treatment as half of our study population was uninsured. We provided charitable care; however, we understand that it may not be realistic for institutions to provide similar services. Therefore, we encourage the establishment of local teledermatology referral networks for charitable care. Through this study, we were able to establish one private practice community partnership. Larger teledermatology referral networks, with the help of our community providers, will help alleviate the high referral

volume, increase patient access to dermatologic care, and encourage volunteerism.

LIMITATIONS

Our pilot study was limited by a small sample size and a low number of PCPs that participated in our pre- and poststudy surveys. PCPs were recruited on a volunteer basis, which can lead to selection bias and limit generalizability of PCP satisfaction. Our study personnel were not blinded during the review of discrepant cases and assignment of partial concordance and discordance.

Conclusion

In conclusion, we established a teledermatology network and were able to provide high-quality care to patients with limited access to specialty care by integrating a mobile phone-based application into an existing EHR. We provided care within our community to clinics outside our care network. Teledermatology significantly increased PCP absolute diagnostic and management concordance, as well as significantly increased PCP confidence in diagnosis and management. There was high-provider satisfaction with the service and low in-person referral rates. A similar process can be utilized by other large health care organizations throughout the United States to provide high-quality consultation to clinics with un- and underinsured populations.

Disclosure Statement

No competing financial interests exist.

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Supplementary Material

Supplementary Figure S1
Supplementary Table S1

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Address correspondence to:
Aaron R. Mangold, MD
Department of Dermatology
Mayo Clinic
13400 E Shea Boulevard
Scottsdale, AZ 85259
USA

E-mail: mangold.aaron@mayo.edu

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