Implementation and Impact of a Store-and-Forward Teledermatology Platform in an Urban Academic Safety-Net Health Care System

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Abstract

Background: *Minority and low-income patients disproportionately experience dermatologic access challenges. Store-and-forward (SAF) teledermatology has emerged as a model of care delivery that may improve access. We sought to evaluate patterns of utilization and overall impact after SAF teledermatology implementation in a safety-net health care system.*

Methods: *We performed a retrospective review of 3,285 teledermatology consultations from 2014 to 2017 in an urban academic safety-net health care system.*

Results: *A total of 1,680 (51.2%) patients were referred for inflammatory/rash conditions and 967 (29.5%) for skin lesions. The teledermatologist recommended in-person evaluation in 1,199 encounters (36.5%). Median wait time for a subsequent appointment was 36 days (range 0–244 days). Of subsequent in-clinic visits, 237 patients (26.4%) underwent skin biopsy. No-show rate after referral was 11.8%. In comparison, median wait time for dermatology appointment through standard referral was 64 days, with a no-show rate of 18.6%. Biopsy rate of patients referred via teledermatology was 26.4%, in comparison to a rate of 10.9% of patients referred directly from primary care provider.*

Discussion: *Implementation of SAF teledermatology in a safety-net health system resulted in avoidance of 63.5% potential dermatology visits. Consultation typically resulted in a change in suspected diagnosis or management plan. Rates of concordance between teledermatology consults and in-person evaluations were high. Median wait time was reduced by almost half, no-show rate was reduced ~37%, and biopsy rate was more than double for teledermatology patients compared with standard referral.*

Conclusion: *These findings suggest that SAF teledermatology may improve access to high-quality dermatologic care and increase clinic efficiencies for patients in safety-net health care systems.*

Keywords: *teledermatology, safety-net hospital, e-consult, telemedicine, store-and-forward*

Introduction

One of three patients presenting to a primary care provider (PCP) has a dermatologic concern.[1] PCPs must determine whether they can manage these concerns independently or whether a dermatology referral is necessary. Dermatology referrals may lead to improved diagnostic accuracy,[2,3] but a high volume of low-acuity referrals exacerbates challenges in access to dermatologic care by compounding already long wait times to see a dermatologist.[4] At-risk populations, such as minority or low-income patients, are disproportionately affected by this access challenge. Specifically, patients with Medicaid experience significantly longer wait times and comprise a smaller than expected proportion of dermatologists' patient population.[5]

Store-and-forward (SAF) teledermatology has emerged as a model of care delivery that may improve access to dermatologic care. Multiple studies have demonstrated the potential of well-designed teledermatology systems to improve dermatologic

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access, decrease costs to patients and health care systems, and increase the number of high-quality referrals to dermatologists.[1,6–9] Studies have also demonstrated comparable rates of diagnostic accuracy and clinical outcomes when comparing teledermatology consultations with in-person visits for a variety of dermatologic conditions.[8–10]

The patient population served by our institution is diverse and historically has faced barriers in access to specialty care. Over half of the patients do not speak English as their primary language, 42% having limited English proficiency. In 2014, our institution introduced an SAF teledermatology platform integrated within our electronic medical record (EMR) system. To evaluate its impact and build upon existing knowledge of the role of teledermatology on diagnosis, management, and access to dermatologic care in underserved populations, we reviewed 3,285 teledermatology encounters from 14 primary care clinics within our hospital system between 2014 and 2017.

Methods

TELEDERMATOLOGY CONSULT

All consults were initiated by providers (physicians, nurse practitioners, physician's assistants) working in 1 of 14 outpatient primary care clinics associated with a single health care organization. Consults were ordered through the EMR and included clinical history, pertinent physical examination findings, photographs obtained by the referring provider, and a clinical question. Teledermatology consults were completed by one of four dermatologists within 48 business hours and returned to the referring provider through the EMR. Consults included a synthesis of clinical history obtained from chart review, description of the clinical images provided, differential diagnosis, and management recommendations. When an in-person dermatologic consultation was recommended, the consultant facilitated scheduling the patient within a time frame they deemed appropriate. Each consult sought to provide educational information to the referring provider related to the diagnosis and management of the referred patient's concern, as well as feedback on the quality of images submitted. It was the responsibility of the referring provider to communicate the dermatologist's assessment and recommendations directly back to the patient and document this in the EMR.

DATA COLLECTION

A retrospective review of all teledermatology consults completed at our institution from initiation of the program in March 2014 through December 2017 was conducted. A list of 3,285 teledermatology consultations was generated using reporting software within the EMR. Medical records were manually reviewed to obtain information regarding patient demographics, teledermatology consultation, and subsequent in-person follow-up with dermatology, when applicable.

The first 340 charts from the above series, ordered by patient alphabetical last name, were selected and analyzed for concordance between the diagnosis and treatment plan of the referring provider and the teledermatologist. In cases where the teledermatology provider recommended an in-person clinic visit, we evaluated concordance between the diagnosis and treatment plan recommended by the teledermatologist and subsequently in the in-person dermatologic encounter.

DATA ANALYSIS

Each chart was reviewed by one physician-author. Where discrepancy or ambiguity occurred, consensus was achieved among two authors. Information was organized into categorical data. Differential diagnosis generated by the consulting teledermatologist was recorded as free text and categorized into one of eight categories (*Table 1*) by a board-certified dermatologist.

For evaluation of diagnostic concordance between the referring provider and the teledermatologist, four categories were created: (1) fully concordant, (2) partially concordant, (3) discordant, and (4) diagnosis not specified by referring provider. Full concordance indicates that the first diagnosis on

Table 1. Patient Demographics

CHARACTERISTIC	*N* (%)
Total No. of encounters	3,285
Female	1,980 (60.3)
Age, years	
<18	176 (5.3)
18 ≤ 40	1,380 (41.8)
40 ≤ 65	1,338 (40.9)
>65	391 (12.0)
Mean age, years (SD)	43.4 (17.7)
Health care coverage	
Medicaid/MassHealth	1,877 (57.1)
Private insurance	941 (28.6)
Medicare	305 (9.4)
Self-pay	107 (3.3)
Medicare + Medicaid	34 (1.0)
Other	21 (0.6)

SD, standard deviation.

the referring provider's differential diagnosis was the same as the first diagnosis on the teledermatologist's differential diagnosis. Partial concordance indicates that the referring provider's top diagnosis was in the differential diagnosis of the teledermatologist but was not the most likely diagnosis. Discordant indicates that the referring provider's suspected diagnosis was not included in the teledermatologist's differential diagnosis. A fourth category indicated cases in which the referring provider did not include a suspected diagnosis in the teledermatology referral.

For patients whose teledermatology consultation resulted in a recommendation for in-person evaluation and a subsequent encounter was completed, a similar framework was used to evaluate diagnostic concordance between the teledermatologist and in-person dermatologist.

Management concordance was similarly analyzed using five categories: (1) fully concordant, (2) partially concordant, (3) discordant, (4) unable to assess because treatment was not specified by the referring provider, and (5) treatment not specified by teledermatology provider and an in-person appointment is requested for further evaluation.

Results

ENCOUNTER CHARACTERISTICS

Our study analyzed 3,285 teledermatology encounters initiated within the 14 primary care clinics. There was substantial growth in teledermatology encounters placed since the initiation of the program from 73 total consults placed in 2014 to 1,817 total consults in 2017. The volume of referrals placed per month rose steadily over the period studied (*Fig. 1*).

In total, 265 unique referring providers initiated teledermatology consults. The number of consults submitted per provider ranged from 1 to 130 (median 6).

PATIENT POPULATION CHARACTERISTICS

Female patients accounted for the majority of encounters (60.3%). Overall, 176 (5.3%) patients were younger than 18 years, 1,380 (41.8%) were between 18 and 39 years, 1,338 (40.9%) were between 40 and 64 years, and 391 (12.0%) patients were 65 years and older.

Patients who obtained their insurance primarily through Medicaid or MassHealth, a Massachusetts public health program that provides health care insurance for low-income residents, accounted for 1,877 (57.1%) encounters. Patients with private insurance accounted for 941 (28.6%) encounters. Patients with Medicare or those eligible under both programs accounted for 305 (9.4%) and 34 (1.0%) encounters, respectively. Self-pay accounted for 107 (3.3%) encounters, whereas no health care insurance information was listed in 21 (0.6%) encounters.

TELEDERMATOLOGY ENCOUNTER OUTCOMES

Diagnostic categories. Inflammatory/rash disorders constituted 1,680 (51.2%) referrals. Skin lesions accounted for 967 (29.5%) cases, whereas disorders of pigmentation compromised 132 (4.0%), acne 100 (3.0%), nail disorder 73 (2.2%), rosacea 67 (2.1%), and alopecia 50 (1.5%) (*Table 2*). Patients referred for skin lesions were much more likely to be recommended for in-person consultation, with 71.9% of them recommended for in-person follow-up compared with 19.2% of patients referred for inflammatory/rash disorders. Photos were considered adequate to provide at least some diagnostic or management advice in 2,902 (88.3%) encounters.

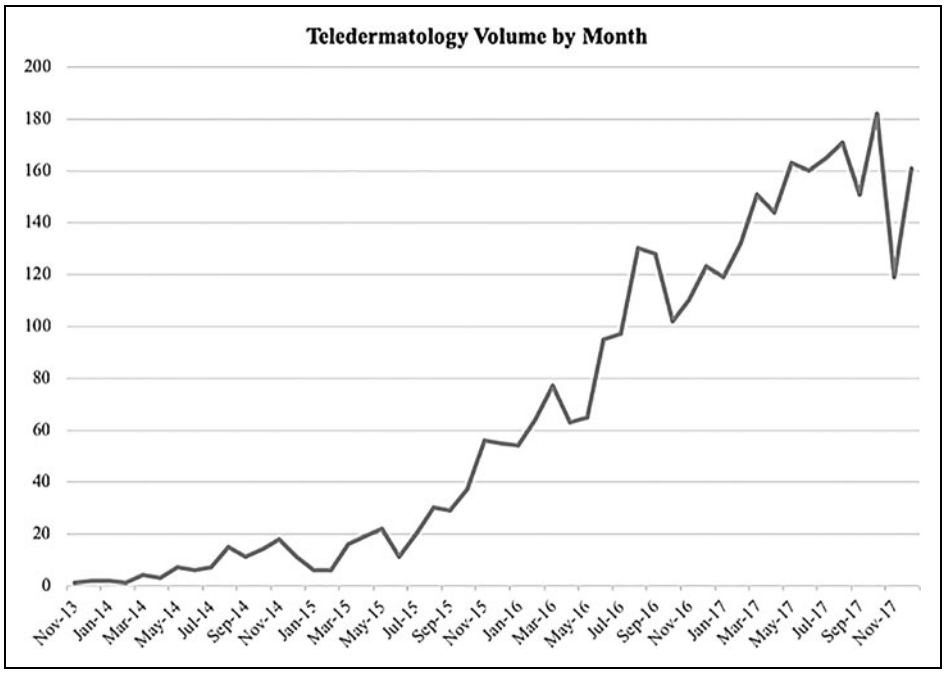

Fig. 1. Volume of teledermatology referrals over time.

Triaging and wait times. Of the 3,285 encounters, 1,199 (36.5%) were recommended to schedule an in-clinic evaluation. For the remaining 2,086 encounters (63.5%), the teledermatologist determined that the clinical question did not necessitate an in-person evaluation at that time and referring providers were

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Table 2. Diagnostic Categories of Teledermatology Referrals

DIAGNOSTIC CATEGORY	
Disease category of teledermatology referrals[a], *n* (%)	
Inflammatory condition/rash	1,680 (51.2)
Skin lesion	967 (29.5)
Disorder of pigmentation	132 (4.0)
Acne	100 (3.0)
Nail disorder	73 (2.2)
Rosacea	67 (2.0)
Alopecia	50 (1.5)
Other/uncertain	216 (6.6)
Disease category where in-person visit recommended, *n* (% of total in category)	
Skin lesion	695 (71.9)
Rash	322 (19.2)
Other	89 (41.2)
Nail disorder	28 (38.4)
Alopecia	22 (44.0)
Disorder of pigmentation	22 (16.7)
Acne	15 (15.0)
Rosacea	6 (9.0)

Diagnoses were rendered by teledermatology.

[a]Examples of disease categories: *Inflammatory/rash:* psoriasis, eczema, lichen simplex chronicus, photodermatitis, arthropod bite(s), pityriasis rosea, and fungal infection. *Skin lesion:* malignancy, wart, nevus, cyst, angioma, venous lake, seborrheic keratosis, scar, and syringoma. *Disorder of pigmentation:* melasma, vitiligo, post-inflammatory hyperpigmentation, and acanthosis nigricans. *Acne:* acne vulgaris. *Nail disorder:* onychomycosis, Beau's lines, leukonychia, melanonychia, subungual hemorrhage, and nail trauma. *Rosacea:* rosacea. *Alopecia:* alopecia areata, telogen effluvium, traction alopecia, trichotillomania, and androgenic alopecia. *Other:* superficial morphea, xerosis, ecchymoses, telangiectasias, generalized pruritus, traumatic erosion, and amyloid.

encouraged to contact the teledermatologist if the patient's clinical condition changed (*Fig. 2*). Recommendations for further in-clinic evaluation resulted in 1,127 (94.0%) referrals to our dermatology clinic; 63 (5.2%) were not referred despite teledermatology recommendation, and 9 (0.8%) were referred to outside providers. The median wait time for a subsequent appointment was 36 days (range 0–244 days). No-show rate after referral was 11.8%. In comparison, the median wait time for a dermatology appointment through standard referral during the study period in our institution was 64 days, with a no-show rate of 18.6%.

Treatment recommendations. Teledermatology consult recommended topical-only treatment in 1,493 (45.4%) cases, systemic-only treatment in 135 (4.1%) cases, both topical and systemic treatment in 384 (11.7%) cases, and no treatment in 1,273 (38.8%) cases. Of these no-treatment encounters, 871 (68.4%) were recommended for further in-clinic evaluation.

In-clinic outcomes. Of 897 subsequent completed in-clinic, 237 (26.4%) patients underwent a skin biopsy. In contrast, the percentage of clinic patients referred directly from PCP who received a biopsy was 10.9%. Following biopsy, 72 patients (30.4% of those biopsied) referred via teledermatology consult had a biopsy-proven skin cancer. Additionally, among the 259 patients seen in clinic for whom the teledermatologist expressed some concern for skin cancer, 110 (42.5%) had a skin biopsy.

RELIABILITY: CONCORDANCE BETWEEN CLINICIANS

PCP and teledermatologist. Concordance between PCP and teledermatologist diagnosis and management plan was evaluated in 340 patients. With respect to diagnosis, 123 encounters (36%) were fully concordant, 82 (24%) were partially concordant, and 77 (23%) were discordant. Concordance could not be assessed in 58 (17%) encounters. Concordance in the management plan between PCP and teledermatologist was fully concordant in 53 encounters (15%), partially concordant in 65 encounters (19%), and discordant in 72 encounters (21%). In 150 (44%) encounters, concordance could not be assessed (*Table 3*).

Teledermatology and in-clinic dermatologist. To determine concordance between the teledermatologist consultant and in-clinic dermatologist, we evaluated 99 encounters that had completed an in-clinic evaluation from the 340 patient cohort. With respect to diagnosis, 76 (77%) encounters were fully concordant, 16 (16%) were partially concordant, and 7 (7%) were discordant. With respect to management, 81 (82%) cases were fully concordant, 13 (13%) were partially concordant, and 5 (5%) were discordant (*Table 3*).

Discussion

This retrospective review of 3,285 teledermatology encounters demonstrates several successes regarding utilization of an SAF teledermatology program within a safety-net health care system. Previous research has indicated that patient populations with similar demographics experience long wait times for dermatologic care[11] and experience relatively high rates of dermatologic disease.[12]

Patients in our series received diagnostic and management feedback from a dermatologist within 48 business hours. In

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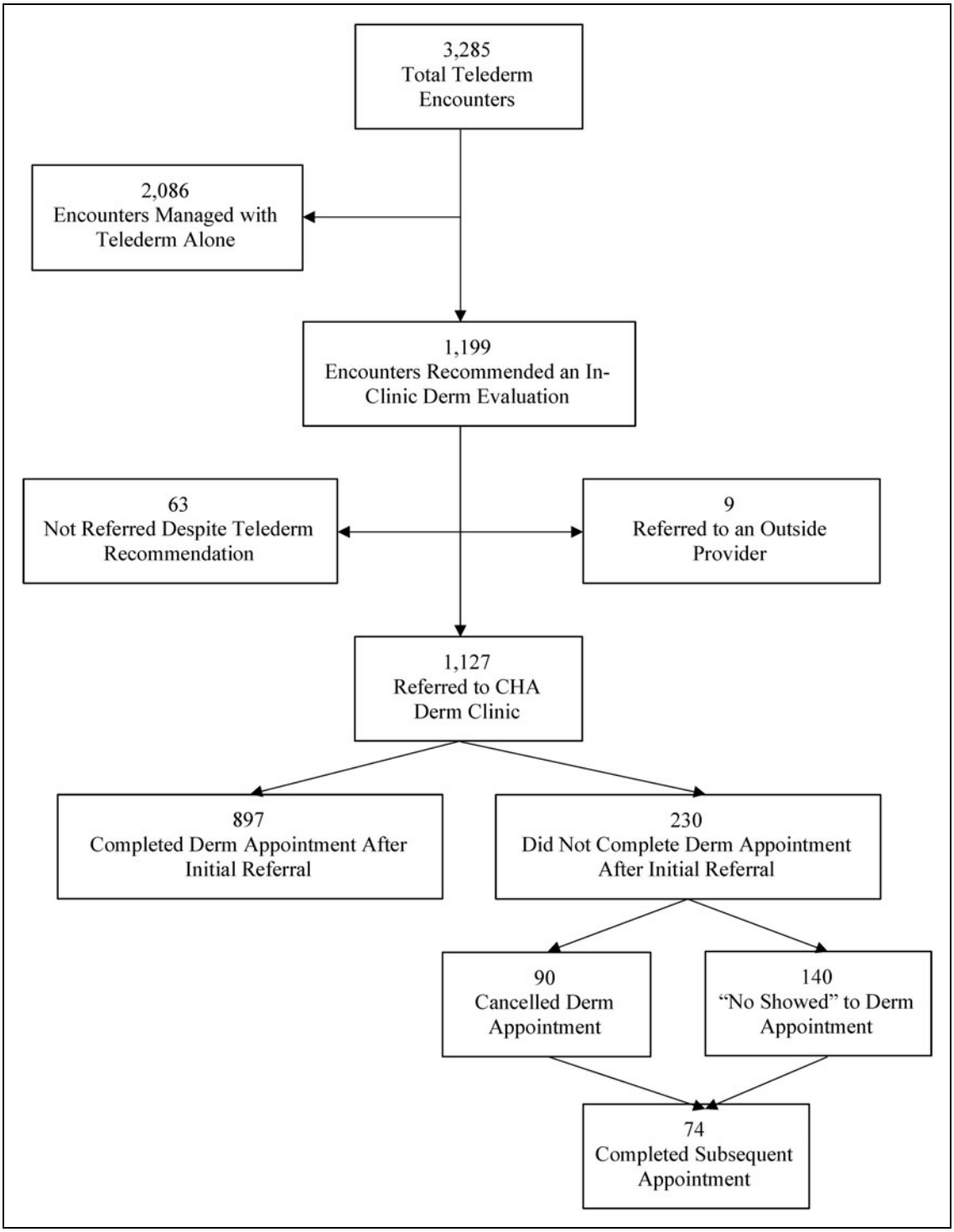

Fig. 2. Teledermatology referral outcomes. CHA, Cambridge Health Alliance.

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Table 3. Diagnostic and Management Concordance Between Referring Providers, Teledermatologists, and In-Clinic Dermatologists

CONCORDANCE COMPARISON	FULLY CONCORDANT, *N* (%) OF CASES	PARTIALLY CONCORDANT, *N* (%) OF CASES	DISCORDANT, *N* (%) OF CASES	UNABLE TO EVALUATE, *N* (%) OF CASES	OBSERVED CONCORDANCE (PARTIAL AND COMPLETE), *N* (%) OF CASES	EXPECTED CONCORDANCE[9,10] (PARTIAL AND COMPLETE), %
Referring PCP vs. teledermatologist ($n=340$)						
Diagnosis	123 (36.2)	82 (24.1)	77 (22.6)	58 (17.1)	205 (60.3)	68
Management	53 (15.6)	65 (19.1)	72 (21.2)	150 (44.1)	118 (34.7)	61
Teledermatologist vs. in-clinic dermatologist ($n=99$)						
Diagnosis	76 (76.8)	16 (16.2)	7 (7.0)	0	92 (92.9)	88
Management	81 (81.8)	13 (13.1)	5 (5.1)	0	94 (94.9)	75

Expected rates determined from previous published reports.[9,10]

PCP, primary care provider.

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63.5% of cases, the dermatologist believed that the referred concern could be managed without an in-person office visit. This creates numerous efficiencies, as patients need not bear additional costs of child care, transportation, and time off from work to attend their appointment. Additionally, in-clinic appointment slots are freed for higher acuity visits.

The percentage of visits that could be managed without an in-person appointment was comparable to other teledermatology programs, with previously reported rates of 31–81%.[7–8,13,14] A recent review noted key factors in improving effectiveness of teledermatology consultation that include appropriate selection of patients, use of high-quality photographs, utilization of dermoscopy for pigmented lesions, and the existence of effective infrastructure.[6] The number of in-person dermatology visits may have been further reduced by routine use of dermoscopy, as consultations for skin lesions frequently led to a recommendation for an in-person visit to improve diagnostic accuracy.

Patients who were referred for an in-person visit after teledermatology consultation completed appointments at relatively high rates. Only 11.8% of patients scheduled for an in-office visit failed to complete a visit in the time frame reviewed, lower than the no-show rate for patients referred through standard channels at our institution, and also lower than previously published rates of 17–31% for missed dermatology appointments.[13,14] The improved rate of appointment completion observed may reflect a selection bias toward higher acuity patients referred for in-office evaluation. First contact with teledermatology may also have increased the likelihood of patients following up, perhaps because patients placed greater value on the appointment after learning a dermatologist had reviewed the case and recommended an in-person evaluation. This is an area that warrants further study.

Rates of biopsy were more than double for patients referred via teledermatology, supporting the notion that these patients have higher acuity concerns. Although the relative acuity of different dermatologic concerns can be difficult to objectively assess, the observed increased frequency of biopsies (26.4% of patients who had a teledermatology consult first compared with 11.8% of patients who were referred via traditional channels) may suggest that the patients referred for in-person evaluation after an initial teledermatology encounter were patients with greater diagnostic challenges or patients with higher concern for skin cancer. This observed increase in biopsy frequency for patients who had a teledermatology consultation first suggests that teledermatology may serve as an effective triage tool in our institution, most likely by screening out patients with low-acuity concerns.

A concern raised about telemedicine services is that it lowers barriers to referral, which may increase low-acuity referrals and ultimately increase cost and inefficiency. Although teledermatology referral rates are likely higher than in-office consultation rates, we suspect that overall efficiencies gained from reduction of low-acuity in-person visits and improved appointment completion rates for referred patients led to improved dermatologic access. Subsequent wait time after referral to a dermatologist was 36 days (and only 25 days in patients with a lesion of concern), almost half of the wait time of 64 days for patients in our clinic who are referred directly from the PCP.[14]

Data from our concordance analysis suggest that this improved access led to improvements in clinical care. Rates of

partial concordance or discordance between referring providers and dermatologists for diagnosis and management were high, 64% and 85%, respectively. Thus, teledermatology led to significant change in both diagnosis and management in a majority of referred cases. Changes in management plans have a high impact on improved clinical outcomes and decreased utilization of health care resources.[15] Overall, these rates are similar to those reported in the literature, with rates of diagnostic discordance ranging from 39% to 78%.[10] Management discordance is variable in the literature, likely related to variability in analyzing this measure.

Rates of concordance between teledermatologists and in-clinic dermatologists were high. Our observed concordance in diagnosis and management were 93% and 95%, respectively. This measure effectively serves as an internal quality control and suggests that information from teledermatology consults was generally adequate for the teledermatologist to provide comparable recommendations to those from an in-office encounter. These rates are slightly higher than the concordance reported in two previous published studies, likely due to the variability in analyzing these measures.

Referring providers demonstrated increasing willingness to use the teledermatology service, despite additional steps in their workflow (*Fig. 1*). This has been observed inconsistently in other studies.[11,16] More than half of referred cases were for rashes, and nearly 30% were for skin lesions. The observed increase in consult use over time may indicate greater awareness, comfort, and perceived value of the system among referring PCPs. An additional benefit to providers and their patients was the directed educational content provided by the teledermatologists, which led to improved dermatologic knowledge among referring PCPs at our institution.[17]

This study should be viewed in light of its strengths and limitations. One strength was the very large number (3,285) of encounters reviewed specifically within a safety-net health care system. A limitation of our study was the lack of comparison to a control group. Randomization of participating clinics may also have improved the quality of our study; however, this was not practical given the immediate need to improve access to care for the patient population served. Finally, studying teledermatology systems in similar institutions may allow for greater generalizability than in the single institution experience reported in this article.

This research adds to the body of evidence that implementation of a teledermatology system can lead to significant benefits in both increasing access to care and improving quality of dermatology care in a safety-net hospital system. Safety-net health care systems have unique challenges and opportunities compared with other systems in that they provide care to high proportions of medically underserved, uninsured, and racial/ethnic minority patients.[17,18] Safety-net hospitals are dependent on funding from the state and federal government and are at greater risk of financial strain given comparably low rates of reimbursements from patients.[19] These institutions often struggle to provide adequate specialty care services.[20] Various groups have made efforts to improve overall access to dermatologic care in the safety-net system.[18] Our data suggest that teledermatology may be a useful tool for increasing prompt access to high-quality dermatologic care in these systems.

Institutions should employ teledermatology platforms with care and awareness about potential limitations. Accuracy of teledermatology may be affected by image comprehensiveness and quality, dermatologist confidence in diagnosis, and difficulty in quickly acquiring additional needed clinical information.[21] Additionally, diagnostic and management accuracy of malignant pigmented lesions via teledermatology is thought to be lower.[9] Finally, the use of teledermatology to assess and triage lesions of concern may be associated with an underdiagnosis of clinically significant lesions that are not recognized by the referring provider.[22]

Conclusions

Implementation of the teledermatology system provided improved access to dermatologic care for a safety-net patient population. Referring providers demonstrated increasing utilization of the service over time. More than half of patients were referred for evaluation of inflammatory dermatoses. Seventy-two skin cancers were diagnosed in the time frame evaluated. Wait times from teledermatology referral were almost halved compared with traditional referral. No-show rates were also lower compared with those from traditional referral. Biopsy rates were doubled compared with standard referral, suggesting a possible improvement in triage of patients with potentially malignant lesions or diagnostically challenging cases. Concordance data suggest that the improved access provided to patients in our system resulted in clinical benefits for patients and that outcomes for teledermatology consultation were similar to in-office visits. Further research on the financial implications of these benefits is critical to facilitate sustainable funding for teledermatology programs that serve safety-net health care systems. Implementation of teledermatology systems should be carried out with careful attention to their benefits and potential limitations.

Disclosure Statement

No competing financial interests exist.

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