Improved patient access and outcomes with the integration of an eConsult program (teledermatology) within a large academic medical center

Rebecca F. Wang, MD,[a] John Trinidad, MD, MPH,[a] Jeffrey Lawrence, MD, MBOE,[b] Llana Pootrakul, MD, PhD,[a] L. Arick Forrest, MD,[c] Kevin Goist, MD,[b] Edward Levine, MD,[d] Shalina Nair, MD, MBA,[e] Milisa Rizer, MD, MPH,[e] Andrew Thomas, MD, MBA,[b] Randell Wexler, MD, MPH,[e] and Benjamin H. Kaffenberger, MD[a]

Columbus, Ohio

Background: Insurance, racial, and socioeconomic health disparities continue to pose significant challenges for access to dermatologic care. Studies applying teledermatology to increase access to underinsured individuals and ethnic minorities are limited.

Objective: To determine how the implementation of a teledermatology program affects access to health care and patient outcomes.

Methods: A cross-sectional evaluation was performed of all ambulatory dermatology referrals and electronic dermatology consultations (eConsults) at Ohio State University within a 25-month period.

Results: Compared with ambulatory referrals, eConsults served more nonwhite patients (612 of 1698 [36.0%] vs 4040 of 16,073 [25.1%]; $P < .001$) and more Medicaid enrollees (459 of 1698 patients [27.0%] vs 3266 of 16,073 [20.3%]; $P < .001$). In addition, ambulatory referral patients were significantly less likely to attend their scheduled appointment compared with eConsult patients, as either "no-shows" (246 of 2526 [9.7%] vs 3 of 62 [4.8%]) or cancellations (742 of 2526 [29.4%] vs 8 of 62 [12.9%]; $P = .003$). There were fewer median days to extirpation for eConsult patients compared with ambulatory referral patients (interquartile range; 80.7 ± 79.8 vs 116.9 ± 86.6 days; $P = .004$).

Conclusion: Integrating dermatologic care through a telemedicine system can result in improved access for underserved patients through improved efficiency outcomes. (J Am Acad Dermatol 2020;83:1633-8.)

Key words: e-Consult; electronic consultation; health disparities; socioeconomic disparities; teledermatology; telemedicine.

Insurance, racial, and socioeconomic health disparities continue to pose significant challenges for health care access.[1-3] These issues are especially prevalent in dermatology, with an uneven distribution as well as a limited supply of dermatologists.[4-6] Patient outcomes also differ. Ethnic minorities and individuals of low socioeconomic status have worse melanoma and

From the Division of Dermatology, Department of Internal Medicine,[a] the Department of Internal Medicine,[b] the Department of Otolaryngology-Head and Neck Surgery,[c] the Division of Gastroenterology, Hepatology, and Nutrition, Department of Internal Medicine,[d] and the Department of Family Medicine,[e] Ohio State University Wexner Medical Center.

Funding sources: This study was funded by the Upper Payment Limit Awards granted through the Ohio Department of Medicaid to Drs Wexler and Kaffenberger.

Conflicts of interest: None disclosed.

IRB approval status: This study used quality control data and was exempt from Institutional Review Board review.

Accepted for publication October 22, 2019.

Reprints not available from the authors.

Correspondence to: Benjamin H. Kaffenberger, MD, OSU Dermatology, 2012 Kenny Rd, 2nd Floor, Columbus, OH 43212. E-mail: Benjamin.Kaffenberger@osumc.edu.

Published online October 31, 2019.

0190-9622/$36.00

https://doi.org/10.1016/j.jaad.2019.10.053

nonmelanoma skin cancer outcomes.[6] Black patients and Medicaid patients are more likely to present with later-stage melanoma.[7] In addition, Medicaid enrollees have lower rates of ambulatory visits to a dermatologist compared with those with private coverage and also experience delay in melanoma treatment.[4,8] Recent studies have demonstrated the use of teledermatology to complement conventional dermatologic care for rural areas that suffer from a shortage of dermatologists.[5,9] However, studies applying teledermatology to increase access to underinsured individuals and ethnic minorities are limited.[10]

With nearly 85 million Americans seen by a physician for skin disease in 2013, addressing disparities in access to dermatologic care is critical.[11] There are 2 primary methods of delivering teledermatology: live interactive video conferencing and the store-and-forward/dys-synchronous method.[12,13] Store-and-forward teledermatology is used more often in the United States, has been shown to result in similar clinical outcomes, and is the method examined in this study.[10,14-17]

CAPSULE SUMMARY

- Although the prevalence of teledermatology programs throughout the country has increased, studies applying teledermatology to increase access to underinsured individuals and ethnic minorities are limited.
- Our study demonstrates that integrating dermatologic care through a telemedicine system can result in improved access for underserved patients through improved efficiency outcomes.

METHODS

Study design and sample population

A cross-sectional study was conducted via retrospective medical record review of all ambulatory referrals and electronic dermatology consultations (eConsults) at Ohio State University within a 25-month period from January 2017 through January 2019. All dermatology referrals at our institution also underwent an unplanned manual audit from January 2018 through March 2018 to examine waiting times for a dermatology appointment as well as the appointment status, including appointment completion, cancellation, or "no-show."

Ambulatory referrals included all conventional referrals to dermatology placed by an outpatient provider, whereas eConsults referred to an integrated platform of store-and-forward teledermatology consults within the electronic medical record (Epic, Madison, WI). For eConsults, referring providers were prompted to select a diagnosis category to allow for a targeted set of questions pertinent to the condition (eg, chronic condition, generalized rash, lesion, etc.) to populate (Supplemental eFig 1; available at Menedley, http://doi.org/10.17632/xtkkymvzf4.1). Using a secure standard digital camera or smart phone application (Haiku or Canto; Epic, Madison WI), providers could then send a digital image of the skin finding, along with the completed question template, to a consulting dermatologist.

Patients were identified by queries of our institution's information warehouse database, and all data were obtained to assess quality assurance of the process. This study was exempt from Institutional Review Board review.

Outcomes of interest

Our primary outcome of interest was the time from the initial referral to biopsy and definitive management among patients ultimately assigned a diagnosis code of D48.5 (neoplasm of uncertain behavior of skin) at the time of dermatology evaluation.

Secondary outcomes of interest included the frequency of eConsult diagnosis categories selected by the referring provider in Epic, eConsult referral volume, eConsult provider reuse rate, appointment waiting time, and the frequency of canceled, no-show, and completed appointments for all patients. The primary outcome, along with appointment waiting time and completion status, was compared between those patients undergoing conventional referrals vs eConsults. Baseline demographic characteristics were also analyzed and compared between both groups.

Statistical analysis

Statistical analysis was performed with χ^2, the Fisher exact test, or the Mann-Whitney U test, as appropriate. P values $<.05$ were considered to be statistically significant. To control for demographic confounding known to affect melanoma and nonmelanoma skin cancer outcomes, multivariable linear regression was performed using log of time to biopsy and excision as the dependent variable with demographic variables including age, sex, race, insurance type, and consult type. Backwards selection to an a priori defined P value of $<.1$ was required to be considered in the final model. All data were analyzed with JMP 14.0 (SAS Institute Inc,

Cary, NC) and Stata (StataCorp, College Station, TX) statistical software.

RESULTS

Patient demographics

Demographics of patients seen by dermatology via ambulatory referral vs eConsults were analyzed (Table I). Compared with ambulatory referrals, eConsults served younger patients (mean ± standard deviation age of 44.6 ± 19.7 vs 47.0 ± 17.6 years; $P < .001$), more male patients (748 of 1698 unique patients [44.1%] vs 6480 of 16,073 [40.3%]; $P = .003$), and more nonwhite patients (612 of 1698 [36.0%] vs 4040 of 16,073 [25.1%]; $P < .001$). In addition, eConsult type referrals included a larger proportion of Medicaid enrollees, at 459 of 1698 patients (27.0%), compared with 3266 of 16,073 (20.3%) ambulatory referral patients ($P < .001$).

eConsult diagnosis categories

The frequency of the categories of dermatologic conditions selected by referring providers via the eConsults question template was calculated. Providers most often used the eConsult service for localized rashes (829 of 2047 encounters [40.5%]), followed by lesions (638 of 2047 [31.2%]).

Referral volume and provider use

During the 25-month study period, the volume of ambulatory referrals remained stable at 1000 to 1400 per month, while eConsults increased from <1% to 10% of all referrals (Fig 1). There were 218 unique referring providers, including 154 physicians (70.6%), who used the service during this period, and 150 (68.8%) of these providers used the eConsult platform more than once. The median time to reuse between providers' first and second eConsult was 29.5 days, with 25% of providers using the eConsult service for the second time within 8 days.

Appointment waiting time and completion status

From January 2017 through January 2019, the mean turnaround time from the eConsult order being placed to a dermatologist completing the teledermatology encounter was 0.46 ± 0.69 business days. The use of eConsults resulted in 80% of patients not requiring a specialty appointment. Those eConsult patients who did require an in-person dermatology follow-up, as recommended by the eConsult dermatologist, or "converted" eConsults, had shorter appointment waiting times and higher completion rates compared with conventional ambulatory referrals (Table II). Patients referred by conventional means waited a median of 26 days (interquartile range, 11-49 days) from the time their ambulatory referral order was placed to their dermatology visit, whereas eConsult patients requiring in-person follow-up waited a median of 11 days (interquartile range, 5-20 days) from the time their eConsult order was placed to their in-person dermatology visit ($P < .001$). In addition, compared with eConsult patients, ambulatory referral patients were significantly less likely to attend their scheduled appointment, as either

Table I. Demographics of patients seen by dermatology via ambulatory referral vs eConsults from January 2017 through January 2019

Variable	Ambulatory referrals (n = 16,073)*	eConsults (n = 1698)*	P value
Age, mean ± SD, y	47.0 ± 17.6	44.6 ± 19.7	<.001†
Sex, No. (%)			.003†
Female	9593 (59.7)	950 (55.9)	
Male	6480 (40.3)	748 (44.1)	
Race, No. (%)			<.001†
Black or African American	2483 (15.4)	373 (22.0)	
Asian	695 (4.3)	105 (6.2)	
Other‡	862 (5.4)	134 (7.9)	
White	12,033 (74.9)	1086 (64.0)	
Insurance, No. (%)			<.001†
Managed care	9463 (58.9)	918 (54.1)	
Medicaid	3266 (20.3)	459 (27.0)	
Medicare	3236 (20.1)	314 (18.5)	
Other§	108 (0.7)	7 (0.4)	

	eConsults (n = 2047)¶
Consult question, No. (%)	
Localized rash	829 (40.5)
Lesions	638 (31.2)
Generalized rash	386 (18.9)
Chronic conditions	90 (4.4)
Hair disorders	33 (1.6)
Nail disorders	57 (2.8)
Palmoplantar rash	14 (0.7)

No., Number; *SD*, standard deviation.
*N refers to the total number of unique patients, and percentages may not add to 100% due to rounding.
†Statistically significant ($P < .05$).
‡"Other" race includes American Indian or Alaskan Native, Native Hawaiian or Other Pacific Islander, more than 1 race, refusal to answer, and race unknown to the patient, and were grouped given their low prevalence in our patient population.
§"Other" insurance includes other government programs and self-pay patients, and were grouped given their low prevalence in our patient population.
¶N refers to total number of patient encounters.

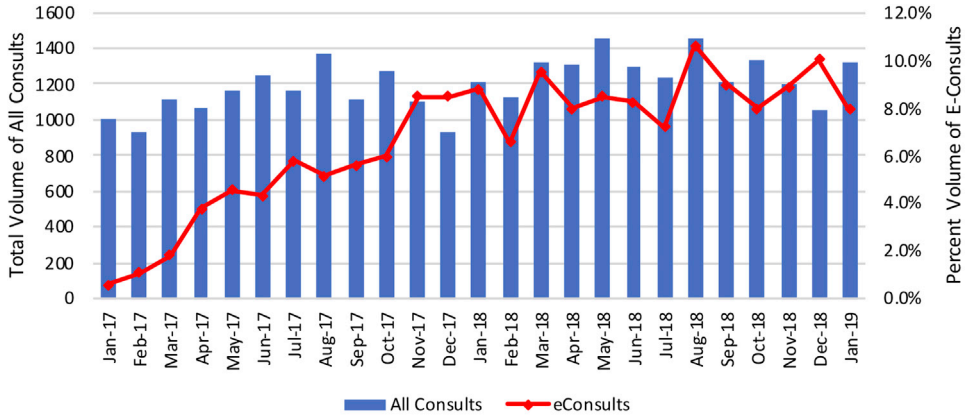

Fig 1. Total volume of all consults and the percentage volume of eConsults from January 2017 through January 2019.

Table II. Comparison of waiting time for a dermatology appointment and appointment status for ambulatory referrals and eConsults from January 2018 through March 2018

Variable	Ambulatory referrals (n = 2526)*	Converted eConsults (n = 62; from 308)*	*P* value
Waiting time for dermatology appointment, d			
Mean ± SD	34.7 ± 32.8	14.3 ± 13.0	<.001†
Median (interquartile range)	26 (11-49)	11 (5-20)	
Appointment within 7 days, No. (%)	514 (20.3)	26 (41.9)	<.001†
Appointment status, No. (%)‡			
Canceled	742 (29.4)	8 (12.9)	.003†
Completed	1504 (59.5)	50 (80.6)	
No-show	246 (9.7)	3 (4.8)	

No., Number; *SD*, standard deviation.
*Percentages may not add up to 100% due to rounding.
†Statistically significant ($P < .05$).
‡Numbers for "Appointment status" do not sum to group totals because the appointment status was not recorded for a small number of patients.

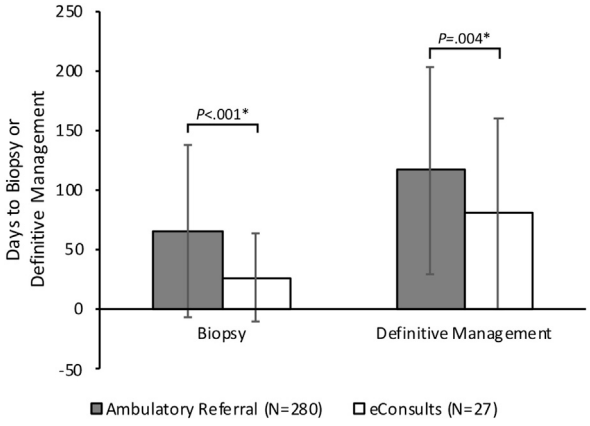

Fig 2. Mean number of days from placement of ambulatory referral or eConsult order to skin biopsy and definitive management of skin cancer from January 2017 through January 2019. *Statistically significant ($P < .05$).

no-shows (246 of 2526 [9.7%] vs 3 of 62 [4.8%]) or cancellations (742 of 2526 [29.4%] vs 8 of 62 [12.9%]; $P = .003$).

Diagnosis and management of suspicious lesions

During the 25 months, 280 ambulatory referrals and 27 eConsults underwent conventional tumor extirpation (referral followed by the first visit for a biopsy, and second visit for a surgical procedure) on a biopsy sample-proven skin cancer. Median days to biopsy for eConsults compared with ambulatory referrals were less (interquartile range; 26.7 ± 37.2 vs 65.4 ± 72.5 days; $P < .001$) (Fig 2). The mean days to extirpation were also less for eConsult patients (80.7 ± 79.8 vs 116.9 ± 86.6 days; $P = .004$) (Fig 2). The final model for the log biopsy time and the associated difference in the geometric mean,

Table III. Multivariable linear regression of referral type and demographic characteristics associated with the natural log of time to biopsy and time to excise

Variable	β coefficient*	Standard error	*t* value	*P* value	95% confidence interval	
Log Biopsy Time						
eConsult	**−0.850**	0.268	−3.17	.002	−1.378	−0.322
Private insurance	**−0.360**	0.163	−2.20	.028	−0.682	−0.039
Age	**−0.014**	0.006	−2.22	.027	−0.027	−0.002
Female sex	0.258	0.155	1.67	.096	−0.046	0.563
Constant	4.440	0.446	9.97	<.001	3.56	5.317
Log Excision Time						
eConsult	**−0.379**	0.160	−2.37	.018	−0.693	−0.064
Private insurance	**−0.180**	0.091	−1.97	.050	−0.359	−0.0003
Constant	4.555	0.062	73.43	<.001	4.433	4.677

*Bold values indicate statistical significance.

contained eConsult vs ambulatory referrals with eConsults associated with a 57% decrease, insurance status (governmental vs private), with private insurance associated with a 30% decrease, and each increased year of age associated with a 1.4% decrease in the geometric mean time to biopsy (Table III).

The final model for the log excision time and their associated change in geometric mean contained eConsult vs ambulatory referrals with eConsults was associated with a 32% decrease, and insurance status (governmental vs private) with private insurance was associated with a 20% decrease in the geometric mean time to extirpate (Table III).

DISCUSSION

Our study demonstrates that integrating dermatologic care through a store-and-forward telemedicine system can result in improved access for underserved patients through improved efficiency outcomes. Over a 25-month period, the eConsult service at our institution served a higher proportion of Medicaid enrollees and nonwhite patients compared with ambulatory referrals. Both of these populations are associated with worse health outcomes, and teledermatology may be an effective method to address this disparity.[4,6-8]

We also documented a continued growth in the use of the eConsult service. The growth in volume of patients was not only associated with an increasing number of unique providers using our service but was also partly due to individual providers reusing the service for subsequent consultations. Although we did not directly measure or survey provider satisfaction in this study, several other studies have noted that providers are satisfied with the teledermatology system.[12,18,19]

This study also demonstrated a benefit to the health system, in that eConsult patients had lower cancellations and no-show rates compared with ambulatory referrals. This may be due to better communication of the importance of an evaluation by a dermatologist. In addition, teledermatology referrals may be seen at an expedited rate once they have already been evaluated by a dermatologist via eConsults, and their follow-up appointment may be scheduled while the skin disease is still most active. Given the loss of revenue associated with cancellation and nonattendance of appointments, eConsults has the potential to be cost-beneficial from an institutional perspective.[20] Further, while conventional referrals were our control group, it is likely that their access times also benefited from the teledermatology arm, because up to 10% of consults at the end of the study period were being seen through teledermatology, and 80% of those did not require a specialty visit.

Given that early recognition and removal of suspicious lesions is important in reducing morbidity and mortality associated with skin cancers, interventions to increase compliance and evaluation of skin lesions are critical.[21] eConsults allow referrals to occur in real-time, therefore positively affecting the adherence rate. In addition, they reduce the waiting time for care, which is also critical in reducing negative outcomes.[22,23]

This study has several limitations. First, because this study was performed at a single institution, these results may not be generalizable to other patient populations. Second, this study included 25 months of data, including the initial months when the teledermatology service was first implemented at our institution. Because the referring and consulting providers were both becoming accustomed to using the service, changes in preference of referral type or patient recommendations may have occurred. Finally, although patient outcomes with teledermatology have been shown to be similar to in-person care, this study did not examine the concordance of

teledermatology diagnoses and patient outcomes at this institution.[12,16]

CONCLUSION

Teledermatology has become increasingly prevalent in delivering dermatologic services to patients in various settings. Through eConsults, we were able to serve a higher proportion of underserved and underinsured groups compared with conventional referrals, providing a much-needed service to a more diverse patient population. Further, this population had lower appointment no-show rates and was able to see an in-person dermatologist and undergo definitive management for skin cancer more quickly compared with conventional referrals. These outcomes are reassuring to continue and build upon the success of the teledermatology program.

REFERENCES

1. Fiscella K, Franks P, Gold MR, Clancy CM. Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. *JAMA*. 2000;283(19):2579-2584.
2. Manuel JI. Racial/ethnic and gender disparities in health care use and access. *Health Serv Res*. 2018;53(3):1407-1429.
3. Williams DR, Purdie-Vaughns V. Needed interventions to reduce racial/ethnic disparities in health. *J Health Polit Policy Law*. 2016;41(4):627-651.
4. Mulcahy A, Mehrotra A, Edison K, Uscher-Pines L. Variation in dermatologist visits by sociodemographic characteristics. *J Am Acad Dermatol*. 2017;76(5):918-924.
5. Coustasse A, Sarkar R, Abodunde B, Metzger BJ, Slater CM. Use of teledermatology to improve dermatological access in rural areas. *Telemed J E Health*. 2019;25(11):1022-1032.
6. Buster KJ, Stevens EI, Elmets CA. Dermatologic health disparities. *Dermatol Clin*. 2012;30(1):53-59.
7. Kooistra L, Chiang K, Dawes S, Gittleman H, Barnholtz-Sloan J, Bordeaux J. Racial disparities and insurance status: an epidemiological analysis of Ohio melanoma patients. *J Am Acad Dermatol*. 2018;78(5):998-1000.
8. Adamson AS, Zhou L, Baggett CD, Thomas NE, Meyer A-M. Association of delays in surgery for melanoma with insurance type. *JAMA Dermatol*. 2017;153(11):1106.
9. Armstrong AW, Kwong MW, Ledo L, Nesbitt TS, Shewry SL. Practice models and challenges in teledermatology: a study of collective experiences from teledermatologists. *PLoS One*. 2011;6(12):e28687.
10. Armstrong AW, Wu J, Kovarik CL, Goldyne ME. State of teledermatology programs in the United States. *J Am Dermatol*. 2012;67(5):939-944.
11. Lim HW, Collins SAB, Resneck JS, et al. The burden of skin disease in the United States. *J Am Acad Dermatol*. 2017;76(5):958-972.e2.
12. Lasierra N, Alesanco A, Gilaberte Y, Magallón R, García J. Lessons learned after a three-year store and forward teledermatology experience using internet: strengths and limitations. *Int J Med Inform*. 2012;81(5):332-343.
13. Lamminen H, Tuomi M-L, Lamminen J, Uusitalo H. A feasibility study of realtime teledermatology in Finland. *J Telemed Telecare*. 2000;6(2):102-107.
14. Whited JD. Teledermatology. *Am J Clin Dermatol*. 2001;2(2):59-64.
15. Dill SW, Digiovanna JJ. Changing paradigms in dermatology: information technology. *Clin Dermatol*. 2003;21(5):375-382.
16. Pak H, Triplett CA, Lindquist JH, Grambow SC, Whited JD. Store-and-forward teledermatology results in similar clinical outcomes to conventional clinic-based care. *J Telemed Telecare*. 2007;13(1):26-30.
17. Du Moulin MFMT, Bullens-Goessens YIJM, Henquet CJM, et al. The reliability of diagnosis using store-and-forward teledermatology. *J Telemed Telecare*. 2003;9(5):249-252.
18. Mounessa JS, Chapman S, Braunberger T, et al. A systematic review of satisfaction with teledermatology. *J Telemed Telecare*. 2018;24(4):263-270.
19. Naka F, Lu J, Porto A, Villagra J, Wu ZH, Anderson D. Impact of dermatology eConsults on access to care and skin cancer screening in underserved populations: a model for teledermatology services in community health centers. *J Am Acad Dermatol*. 2018;78(2):293-302.
20. Penneys NS, Glaser DA. The incidence of cancellation and nonattendance at a dermatology clinic. *J Am Acad Dermatol*. 1999;40(5 Pt 1):714-718.
21. Glazer AM, Rigel DS, Winkelmann RR, Farberg AS. Clinical diagnosis of skin cancer. *Dermatol Clin*. 2017;35(4):409-416.
22. Ludwick DA, Lortie C, Doucette J, Rao J, Samoil-Schelstraete C. Evaluation of a telehealth clinic as a means to facilitate dermatologic consultation: pilot project to assess the efficiency and experience of teledermatology used in a primary care network. *J Cutan Med Surg*. 2010;14(1):7-12.
23. Whited JD, Hall RP, Foy ME, et al. Teledermatology's impact on time to intervention among referrals to a dermatology consult service. *Telemed J E Health*. 2002;8(3):313-321.