Cost analysis of a store-and-forward teledermatology consult system in Philadelphia

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Background: Store-and-forward (SAF) teledermatology (TD) has the potential to increase access to timely, high-quality care for underserved populations. However, the cost-effectiveness of TD for underserved populations is uncertain.

Objective: This study evaluates the potential cost savings associated with an SAF TD program implemented for an underserved population in the city health clinics of urban Philadelphia.

Methods: We performed a retrospective analysis of SAF TD consultations for 700 outpatients managed in 12 Philadelphia primary care clinics. Primary care providers were asked to specify a treatment plan, as well as the type of care for the patient, in the absence of the TD service. Analysis compared the cost of each patient case with use of the TD consult model versus with conventional care.

Results: In all, 27% of in-person dermatology clinic visits (189 of 700) and 3.29% of emergency room visits (23 of 700) were avoided by using TD. Compared with conventional care, TD had a mean expected cost savings of $10.00 to $52.65 per TD consult. In sensitivity analyses, these estimated savings remained positive across a range of parameters.

Limitations: The cost analysis relies on several assumptions regarding the cost of care, and indirect costs were not included.

Conclusion: TD can be a cost-saving model while increasing access to dermatologic care. (J Am Acad Dermatol 2019;81:758-64.)

Key words: access to care; cost analysis; dermatology; mHealth; store-and forward; teledermatology.

Given the maldistribution of dermatologic services, long wait times for appointments, and potential delays in obtaining critical diagnoses and treatments, store-and-forward (SAF) teledermatology (TD) has the ability to increase access to high-quality dermatologic care.[1-6] SAF TD allows for the transmission of a patient's medical information and photographs from one site to a dermatologist at another site without the presence of the patient. The dermatologist then reviews the patient's case and sends his or her opinion at another point in time. TD may be particularly valuable for underserved populations, such as Medicaid patients and uninsured populations, who historically have had significantly limited access to dermatology care because of the low reimbursement for services and heavy administrative burdens for delivering care.[7]

Abbreviations used:

ER:	emergency room
PCP:	primary care physician
SAF:	store-and-forward
TD:	teledermatology

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SAF TD may also have the potential to improve efficiency and provide cost-effective care. However, there is a scarcity of research on the economic impact of TD, particularly among underserved populations. This study evaluates the potential cost savings associated with an SAF TD program among an underserved population of patients cared for in city health clinics in urban Philadelphia.

CAPSULE SUMMARY

- When conducted appropriately, store-and-forward teledermatology can provide cost savings by reducing unnecessary office-based dermatology clinic and emergency room visits.
- With engagement of stakeholders and proper planning, patients can obtain improved access to high-quality and sustainable dermatologic care in the setting of teledermatology reimbursement.

METHODS

Study design

A retrospective study of the cases submitted to the AccessDerm TD system in Philadelphia from December 2012 to June 2017 was conducted. This study encompassed 700 outpatient visits requiring dermatology consultation in 12 primary care clinics. Within these Philadelphia community health centers, 48% of the patients are covered by Medicaid, uninsured patients (35% of the centers' patients) receive care on a sliding scale based on family size and income, and Medicare and other types of insurance are also accepted.[8] In addition, 97% of patients served by these clinics have incomes less than 200% of the federal poverty level ($40,000/y for a family of 4). Primary care providers (PCPs) who provided health care to underserved populations in Philadelphia collected clinical information and submitted TD consultation requests through AccessDerm. The PCPs were asked to specify a diagnosis and treatment plan, as well as the type of care that would be provided for the patient in the absence of the TD service. Requests for dermatologic consultations were sent to a group of dermatologists at the University of Pennsylvania, and the requests were answered within 48 hours. This study was approved by the University of Pennsylvania institutional review board.

The AccessDerm mobile SAF platform (Vignet Corporation, Fairfax, VA),[9,10] which was developed by the American Academy of Dermatology to reach underserved populations in the United States, was used for TD as a volunteer service during the study period. The platform could be used on Google Android smart phones (HTC Corporation, New Taipei City, Taiwan), iPhones, iPads (Apple Corporation, Cupertino, CA), and a World Wide Web–based interface. Dermatologists received the TD consultation requests and would provide a diagnosis (or differential diagnosis), provide a treatment plan, make a recommendation regarding an in-person visit, or ask for additional information.[11]

In addition to sending the consultation request, PCPs gave their responses to the question "without the TD service, how would this patient have otherwise received care for this condition?" The answer choices included (1) "I would take care of the issue myself," (2) "I would refer the patient for an in-person dermatologist visit," and (3) "I would refer the patient to urgent care or an emergency room (ER)." Consult management by TD alone was based on the initial recommendation of the dermatologist for or against in-person evaluation. Dermatologists evaluated the patient through TD and then gave a yes or no response as to whether an in-person evaluation of the patient by the dermatologist was required. If an in-person visit was not required, the dermatologist would render the diagnosis and treatment plan through the TD platform.

Costs

A cost analysis using US dollars was performed to estimate the cost related to this SAF TD program. An extensive literature search was conducted to estimate the cost range and average cost for an in-person dermatology visit, a TD visit, and a dermatology-related ER visit.[12-18] We included the direct medical costs of health care, such as the average cost of an in-person dermatology visit, the average cost of an emergency dermatology visit, and average payment to the dermatologist for a TD visit. Costs were calculated by using national averages of direct costs for in-person visits. The overall average cost of an in-person dermatology visit (which may or may not have included a biopsy) was used in the calculation, given that the patient in a TD case may be referred for an in-person visit for many reasons, including the need for a more thorough physical examination or work-up in a complex case, and a biopsy may or may not be required. The cost of TD care is the cost of the time spent by the dermatologist on the visit to render diagnosis and treatment recommendations. Separate costs for medications, patient travel, laboratory work and/or imaging, or procedures outside of the visits were not included in the analysis. Only the costs of the visits were included.

Table I. Characteristics of TD consults (N = 700)

Characteristics	n	%
Patient age, y		
Median	40.1 ± 20.8 (0.2-82)	
Sex		
Male	366	52.3
Female	320	45.7
Unspecified	14	2.0
In the absence of TD, PCPs would		
Take care of dermatologic issue themselves	420	60.0
Refer to dermatology	249	35.6
Refer to emergency room	31	4.4
Dermatologist recommends in-person visit		
Yes	98	14.0
No	602	86.0

PCP, Primary care physician; *TD*, teledermatology.

Using these assumptions, we calculated the estimated cost of care for each consult by using the PCP's recorded plan if TD were not available versus the expected costs incurred with this TD system. For instance, if PCPs reported that they would care for the patient themselves but the teledermatologist recommended an in-person evaluation, the additional cost incurred as a result of use of the TD system would be the cost of the TD consult plus the cost of the in-person dermatology consult that would not have occurred in the standard of care without TD. In contrast, if the PCPs reported that in the absence of TD, they would have referred the patient for an in-person dermatology evaluation but the teledermatologist recommended care via TD alone, the cost savings would be the cost of the avoided dermatology visit minus the additional cost of the TD visit.

Statistical analysis

Descriptive statistics, frequencies, and percentages for categoric variables were provided for all demographic and recommended referral outcome variables. Chi-square analyses were performed to test the differences of referral consult recommendations between PCPs and dermatologists. Cost savings were assessed according to the average cost of clinic visit, TD, and ER visit in the literature. All statistical analyses were performed with SPSS software (version 25; IBM Corp, Armonk, NY), and 2-tailed probability values less than .05 were considered to indicate statistical significance.

RESULTS

Study enrollment

In this study, TD consultations regarding 700 patients with skin disease conditions were reviewed. In all, 10 dermatologists responded to the consult requests submitted by 52 PCPs. Baseline demographic characteristics of the participants and consults are listed in Table I. Of these participants, 366 (52.3%) were male, and the median age of the participants was 40.1 plus or minus 20.8 years.

In the absence of TD services, the majority of cases would have been taken care of by the PCP (60.0%), and a significant number would have been referred to dermatology services (35.6%). Just 4.4% of patients would have been sent to the ER by the PCP. The majority of cases were able to be cared for by the dermatologist through TD (86%), without an in-person visit.

The distribution of outpatient consult recommendations between PCPs and dermatologists are shown in Table II. There were significant differences in care plan recommendations between the PCPs and dermatologists (χ^2 = 41.073 [$P < .001$]). There were 23 cases (3.29% of all cases) for which PCPs recommended ER visits and 189 cases (27.0% of all cases) for which PCPs recommended an in-person dermatology consultation but the dermatologists recommended dermatologic care by TD only.

Table III highlights the estimated cost savings of this SAF TD program. The total expected cost savings for the entire program from TD ranged from $6997.30 to $36,854.40, depending on the assumed cost of the ER, TD, and in-person dermatology visits. The mean expected cost savings ranged from $10.00 to $52.65 per TD consult. The avoided unnecessary clinic visits and ER visits saved an estimated $2967.30 to $48,951.00 and $15,525 to $29,279.00, respectively when analyzing the combined 700 total patients. Tables IV and V display sensitivity analyses across a range of potential values for the cost of TD, in-person dermatology visits, and ER visits (ER visit costs are kept constant at $1028.70 in Table IV, and in-person dermatology visit costs are kept constant at $202.60 in Table V).[16,17] Across a range of potential values, SAF TD remained cost-effective, except when the maximum cost of TD visits and the minimum costs of either ER or in-person dermatology clinic visits were tested.

DISCUSSION

This study highlights the cost-effectiveness of an SAF TD program implemented in an underserved community in urban Philadelphia. In addition to providing access to high-quality care, this program reduced unnecessary in-person dermatology clinic visits as well as ER visits. This system of SAF TD was implemented in Philadelphia community health centers, where the most common health coverage is Medicaid. Unfortunately, insurance coverage,

Table II. Cost assumptions for usual care and TD

Type of care	Additional cost of care
PCP work flow in the absence of TD	
PCPs take care of patients themselves	$0
PCPs refer to dermatology	$103.70[14]-$283.00[13] for in-person dermatology visit
PCPs refer to the emergency room	$763.00[15]-$1297.00[16] for ER visit
PCP work flow in the presence of TD	
PCPs refer case to TD	$24.00[12]-$88.00[13] for TD visit

PCP, Primary care physician; *TD*, teledermatology.

Table III. Cost savings by using TD (N = 700)

n	Patient care without TD	Patient care with TD	Added cost of patient care without TD	Cost of dermatology intervention with TD	Cost savings/$ per person
30	PCPs would have taken care of the patient themselves	Patient referred for TD and then for in-person dermatology visit	$0	$127.70-$371.00	−$127.70 to −$371.00
390	PCPs would have taken care of the patient themselves	Patient managed with TD only	$0	$24.00-$88.00	−$24.00 to −$88.00
60	PCP refers patient to in- person dermatologist	Patient referred for TD and then for in-person dermatology visit	$103.70-$283.00	$127.70-$371.00	−$24.00 to −$88.00
189	PCP refers patient to in-person dermatologist	Patient managed with TD only	$103.70-$283.00	$24.00-$88.00	$15.70-$259.00
8	PCP refers patient to emergency room	Patient referred for TD and then for in-person dermatology visit	$763.00-$1297.00	$127.70-$371.00	$392.00-$1169.30
23	PCP refers patient to emergency room	Patient managed with TD only	$763.00-$1297.00	$24.00-$88.00	$675.00-$1273.00
Total = 700					$10.00-$52.65

PCP, Primary care physician; *TD*, teledermatology.

especially Medicaid, does not translate to access to specialty services. As noted in a study by Mulcahy et al, Medicaid patients overall have poor access to dermatologists owing to the lack of in-network dermatologists and long wait times for the appointments.[19,20] In 1 study examining access of pediatric patients to dermatologists, Chaudhry et al found that an average of 44% of dermatologists had refused a new Medicaid-insured pediatric patient.[21] In Philadelphia, a recent study showed that the overall wait time for the next available routine appointment was more than 2 months.[22]

Before TD was implemented, the patients in these clinics with dermatologic issues had 1 of 3 options: (1) the PCP took care of the dermatologic condition as best they could, (2) the PCP sent the patient to the ER, or (3) the PCP tried to send the patient to a dermatologist if he or she had insurance coverage. If the patient had no insurance coverage, the city would often try to refer the patient and cover the costs through a limited Health Department budget. From previous studies, we know that there is considerable discordance in diagnosis and treatment decisions between PCPs and dermatologists, likely leading to unnecessary costs for the patients when managed by the PCP alone.[11] In addition, ER use can decrease when dermatologic expertise is available to PCPs, thus decreasing morbidity, complications, and cost.[23] Given the long wait times for Medicaid patients to see a dermatologist, the primary complaint may worsen, possibly leading to an ER or urgent care visit, or resolve by the time the visit date arrives. Our results demonstrate that this model may not only provide overall cost savings with the use of TD care but also allow this population to access a

Table IV. Average cost savings per person based on variable TD and clinic visit costs

TD cost	Minimum clinic visit cost of $103.70	Mean clinic visit cost of $202.60	Maximum clinic visit cost of $283.00
Minimum TD cost of $24.00	$43.93	$65.26	$82.60
Mean TD cost of $49.47	$18.46	$39.79	$57.13
Maximum TD cost of $88.00	−$20.07	$1.26	$18.60

Amounts are based on a calculation with use of a mean emergency room visit cost of $1028.70 as a constant.
TD, Teledermatology.

Table V. Average cost savings per person, based on variable TD and ER visit costs

TD cost	Minimum ER visit cost $763.00	Mean ER visit cost $1028.70	Maximum ER visit cost $1297.00
Minimum TD cost of $24.00	$53.49	$65.26	$77.14
Mean TD cost of $49.47	$28.02	$39.79	$51.67
Maximum TD cost of $88.00	−$10.51	$1.26	$13.14

Amounts are based on a calculation with the mean in-person dermatology visit costs kept constant at $202.60.
ER, Emergency room; *TD*, teledermatology.

dermatologist in a more efficient manner with telemedicine services within 24 to 48 hours and to obtain in-person care when needed.

The economic analysis revealed that overall, SAF TD provided cost savings by reducing the number of unnecessary office-based clinic and ER visits. The mean cost savings were estimated at $10.00 to $52.65 per consult. The most significant costs that were avoided by the implementation of SAF TD were the costs of the in-person dermatology referral visits and the ER visits recommended by PCPs that the dermatologists would have handled through TD only. Avoidance of unnecessary care occurred in a significant number (>30%) of the clinical cases. Approximately 27.0 % of clinic referrals by the PCPs (189 of 700) would have been prevented, which is similar to the estimates of 13% to 58% in a prior study with SAF TD.[24] Increasing the percentages of preventable referral consultations could result in a reduction of the overall costs of a TD program, and about $6997.30 to $36854.40 would have been saved through SAF TD in this study. Additionally, the SAF TD program avoided 3.29% of referrals for ER visits, which resulted in significant cost savings to the program.

This model has the potential to allow for significant reduction of expenditure of dermatologic care while increasing access and improving patient satisfaction and clinical outcomes.[25-28] According to prior literature, conducting an SAF TD consultation is estimated to cost approximately $24.00 to $88.00 per patient.[12,13] Adequate and reliable systems for reimbursement will be necessary to encourage physician and patient participation in TD, as well as engagement on the part of the health system. The high demand for dermatology care and shortage of providers require patients to wait longer for appointments and spend more money for the dermatology care. In this study, most patients were from the community health centers in Philadelphia and were primarily covered by Medicaid; these patients' dermatologic issues are often neglected, misdiagnosed, or treated at higher cost on account of lack of access to dermatologists.[19,20,29,30] These patients will often be treated by their primary doctors, or they may be sent to an ER where they can receive expedited care. In some cases, the patient may receive a dermatology appointment, but the long wait time allows his or her condition to progress.

For TD to gain widespread application for specialty care, fair reimbursement for those providing the service will need to be a priority, particularly for SAF telemedicine, which is covered for individuals insured by Medicaid in only 15 states.[31] Alternatively, given the cost savings identified for this program, there may be opportunities for direct compensation models to encourage more dermatologists to participate in care for underserved populations through SAF TD.

Limitations

This study has several limitations. First, it was conducted only in Philadelphia, and thus, generalization to other areas or populations remains unclear. In addition, the cost analysis relied on several assumptions regarding the cost of care in various settings. Although an extensive literature review was conducted to determine these assumptions and sensitivity analyses were performed across a range of potential values from the literature, it is possible

that the actual cost of such a program may differ from our estimates. We also did not include the cost of the PCPs' time, including when patients are sent back to them for management after a TD visit. However, in our model we also did not include associated indirect costs, such as travel costs and lost productivity associated with visits; thus, our model may in fact underestimate the value of TD to this community.

CONCLUSION

Implementation of an SAF TD system, especially in this population, provides the potential for patients to have improved access to care, for dermatologists to receive payment for their services, for health systems to serve their patient populations appropriately, and for payers to decrease costs.[29] This cost analysis provides a structure on which programs interested in creating a financially sustainable TD program can build. Overall, there has been a scarcity of research on the economic impact of TD. Additional studies need to be done to build on this data to understand how the economic burden of limited access to care may drive clinicians to alter how they provide dermatologic care and how patients seek it. In this setting, TD may make it possible to appropriately minimize the cost of dermatologic services while still providing high-quality care.

REFERENCES

1. Uhlenhake E, Brodell R, Mostow E. The dermatology work force: a focus on urban versus rural wait times. *J Am Acad Dermatol*. 2009;61(1):17-22.
2. Camacho F, Balkrishnan R, Khanna V, Khanna K, Feldman SR. How happy are dermatologists' patients? *The Dermatologist*. 2013;21(4).
3. Ogbechie OA, Nambudiri VE, Vleugels RA. Teledermatology perception differences between urban primary care physicians and dermatologists. *JAMA Dermatol*. 2015;151(3):339-340.
4. de la Torre-Díez I, López-Coronado M, Vaca C, Aguado JS, de Castro C. Cost-utility and cost-effectiveness studies of telemedicine, electronic, and mobile health systems in the literature: a systematic review. *Telemed J E Health*. 2015;21(2):81-85.
5. Yim KM, Florek AG, Oh DH, McKoy K, Armstrong AW. Teledermatology in the United States: an update in a dynamic era. *Telemed J E Health*. 2018;24:691-697.
6. Mayer Jonathan E. Reimbursement for teledermatology in the United States: a review. *Health Technol*. 2015;5:67-71.
7. Peace and Freedom; Policy and World Ideas. A doctor's Declaration of Independence — it's time to defy health-care mandates issued by bureaucrats not in the healing profession. Available at: https://johnib.wordpress.com/2014/04/29/a-doctors-declaration-of-independence-its-time-to-defy-health-care-mandates-issued-by-bureaucrats-not-in-the-healing-profession/. Accessed June 28, 2018.
8. Health Federation of Philadelphia. Community health centers in southeastern PA. Available at: http://healthfederation.org/CommunityHealthCenters. Accessed June 28, 2018.
9. American Academy of Dermatology. AccessDerm Teledermatology program. Available at: http://www.aad.org/members/volunteer-and-mentor-opportunities/accessdermteledermatology-program. Accessed June 15, 2014.
10. James WD. The use of technology in providing dermatologic care to vulnerable populations. *Cutis*. 2012;89:53-54.
11. Nelson CA, Takeshita J, Wanat KA, et al. Impact of store-and-forward (SAF) teledermatology on outpatient dermatologic care: a prospective study in an underserved urban primary care setting. *J Am Acad Dermatol*. 2016;74(3):484-490.e1.
12. Whited JD, Datta S, Hall RP, et al. An economic analysis of a store and forward teledermatology consult system. *Telemed J E Health*. 2003;9(4):351-360.
13. Pak HS, Datta SK, Triplett CA, Lindquist JH, Grambow SC, Whited JD. Cost minimization analysis of a store-and-forward teledermatology consult system. *Telemed J E Health*. 2009;15(2):160-165.
14. Rothstein BE, Gonzalez J, Cunningham K, Saraiya A, Dornelles AC, Nguyen BM. Direct and indirect patient costs of dermatology clinic visits and their impact on access to care and provider preference. *Cutis*. 2017;100(6):405-410.
15. Dommasch ED, Joyce CJ, Mostaghimi A. Trends in nationwide herpes zoster emergency department utilization from 2006 to 2013. *JAMA Dermatol*. 2017;153(9):874-881.
16. Ho V, Metcalfe L, Dark C, et al. Comparing Utilization and costs of care in freestanding emergency departments, hospital emergency departments, and urgent care centers. *Ann Emerg Med*. 2017;70(6):846-857.
17. MEPS Statistical Briefs. Expenses for office-based physician visits by specialty, 2013. Available at: https://www.ncbi.nlm.nih.gov/books/NBK447197/. Accessed November 1-5, 2015.
18. CA.gov. California Department of Healthcare Services. Medi-Cal rates as of 10/15/2018. http://files.medi-cal.ca.gov/pubsdoco/Rates/rates_download.asp. Accessed September 10, 2018.
19. 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.
20. Alghothani L, Jacks SK, Vander Horst A, Zirwas MJ. Disparities in access to dermatologic care according to insurance type. *Arch Dermatol*. 2012;148(8):956-957.
21. Chaudhry SB, Armbrecht ES, Shin Y, et al. Pediatric access to dermatologists: medicaid versus private insurance. *J Am Acad Dermatol*. 2013;68(5):738-748.
22. Jayakumar KL, Samimi SS, Vittorio CC, et al. Expediting patient appointments with dermatology rapid access clinics. *Dermatol Online J*. 2018;24(6).
23. Beal BT, Prodanovic E, Kuo JE, Armbrecht ES, Peter MD JR, Siegfried EC. Impact of a pediatric dermatology service on emergency department utilization for children with dermatitis. *Pediatr Dermatol*. 2016;33(1):69-74.
24. Pak HS, Edison KE, Whited JD. *Teledermatology: A User's Guide*. Cambridge, UK: Cambridge University Press; 2008.
25. Datta Santanu K, Warshaw Erin, Edison Karen, et al. Cost and utility analysis of a store-and-forward teledermatology referral system a randomized clinical trial. *JAMA Dermatol*. 2015;151(12):1323-1329.
26. Fogel AL, Sarin KY. A survey of direct-to-consumer teledermatology services available to US patients: explosive growth, opportunities and controversy. *J Telemed Telecare*. 2017;23(1):19-25.
27. Armstrong AW, Dorer DJ, Lugn NE, Kvedar JC. Economic evaluation of interactive teledermatology compared with conventional care. *Telemed J E Health*. 2007;13(2):91-99.
28. Landow SM, Mateus A, Korgavkar K, Nightingale D, Weinstock MA. Teledermatology: key factors associated with

reducing face-to-face dermatology visits. *J Am Acad Dermatol*. 2014;71(3):570-576.

29. Stoff BK, Bercovitch L, Grant-Kels JM. The case for equal access to urgent dermatology appointments for Medicaid beneficiaries: when professional duty conflicts with economic reality. *J Am Acad Dermatol*. 2015;72(1):181-183.
30. Uscher-Pines L, Malsberger R, Burgette L, Mulcahy A, Mehrotra A. Effect of teledermatology on access to dermatology care among Medicaid enrollees. *JAMA Dermatol*. 2016;152(8):905-912.
31. Center for Connected Health Policy. CCHP's annual survey and analysis of state telehealth laws and reimbursement policies shows that no two states approach telehealth in the same way. Available at: http://www.cchpca.org/telehealth-medicaid-state-policy. Accessed September 10, 2018.