Inpatient teledermatology: Diagnostic and therapeutic concordance among a hospitalist, dermatologist, and teledermatologist using store-and-forward teledermatology

Jesse J. Keller, MD,[a] Jacob P. Johnson, MA,[a] and Emile Latour, MS[b]
Portland, Oregon

Background: Inpatient dermatology has been shown to improve patient outcomes at a reduced cost. Few hospitals have dermatologists available. Teledermatology may allow dermatologists to assess hospitalized patients remotely.

Objective: To examine the diagnostic concordance between a hospitalist, dermatologist, and teledermatologist using store-and-forward teledermatology.

Methods: For 100 consecutive patients requiring inpatient dermatology consultation, a survey was conducted by all 3 raters to convey diagnostic impressions and therapeutic recommendations. Complete and partial agreements were assessed using the Cohen kappa statistic.

Results: Inpatient dermatology consultation often resulted in a change in diagnosis (50.9%) and a change in systemic therapy (41.5%). Likewise, virtual teledermatology consultation would have resulted in a change in diagnosis (54.7%) and a change in systemic therapy (47.2%) at similar rates. Comparing the dermatologist and teledermatologists, diagnostic complete and partial agreement were 52.8% and 84.9%, respectively. Systemic therapy agreement was 77.4%. Teledermatologists recommended biopsy more often (68.5% vs 43.5%).

Limitations: Small sample size, tertiary academic medical center, single rater for inpatient teledermatology with specific inpatient niche.

Conclusion: Teledermatologists performed comparably to an in-person dermatologist for the diagnosis and management of hospitalized patients with skin conditions. Teledermatology may be a suitable alternative for delivery of inpatient care if no dermatologist is available. (J Am Acad Dermatol 2020;82:1262-7.)

Key words: agreement; concordance; dermatology; inpatient; teledermatology; telehealth; telemedicine.

Prior studies have shown that teledermatology can improve access, improve patient satisfaction, and provide a cost-effective model of care.[1-4] The use of teledermatology in the inpatient setting is still being explored. The potential for teledermatology to connect inpatient consultations with offsite dermatologists suggests that this technology could improve outcomes and reduce costs for inpatients. Inpatient dermatology consults are associated with shorter duration of antibiotic therapy and

From the Department of Dermatology[a] and Biostatistics Shared Resource, Knight Cancer Institute, Oregon Health & Science University, Portland.[b]
Funding sources: None.
Conflicts of interest: None disclosed.
IRB approval status: Reviewed and approved by the Oregon Health & Science University IRB (17365).

Accepted for publication January 11, 2020.
Reprint requests: Jesse J. Keller, MD, 3303 SW Bond Ave CH16D, Portland, OR 97239. E-mail: kellerje@ohsu.edu.
Published online January 20, 2020.
0190-9622/$36.00

https://doi.org/10.1016/j.jaad.2020.01.030

hospital stay for cellulitis and with reduced readmission rates for patients with inflammatory skin diseases.[5-8] Li et al[6] found that early consultation with a dermatologist for cases of presumed cellulitis could result in nationwide cost savings of $210 million annually. Studies that compare triage decisions between in-person dermatologists and teledermatologists show that concordance rates can be high (>90%), suggesting that teledermatology could effectively substitute for an in-person consult.[9-11] In this study, our primary aim was to assess agreement in diagnosis and treatment recommendations among the hospitalist, an inpatient dermatologist, and teledermatologists using store-and-forward teledermatology. A secondary aim was to assess propensity for the inpatient dermatologist and teledermatologists to recommend biopsy. We hypothesized that concordance between dermatologists and teledermatologists would exceed 75%. We hypothesized that concordance between either type of dermatologist and hospitalists would be near 50%. We hypothesized that teledermatologists would recommend biopsy more often than dermatologists.

CAPSULE SUMMARY

- We show that consultative dermatology often changes management in the inpatient setting.
- Our findings suggest that virtual care of inpatients may be suitable and that further research should be directed to assessing measurable patient outcomes when providing inpatient consultation using store-and-forward teledermatology.

METHODS

Setting

The study was conducted at a single tertiary academic medical center. Consecutive dermatology consultations from inpatient and emergency room settings were included until a predetermined goal of 100 patients was achieved. These consultations took place over a 9-month period from November 2017 to August 2018.

Raters

For each subject, a survey was completed by 3 raters. This included the primary team or hospitalist, the inpatient dermatologist, and a teledermatologist. The primary team consisted of providers representing internal medicine, emergency, hematology-oncology, or surgery specialties. Inpatient consultations were primarily seen by a single board-certified dermatologist specializing in hospital dermatology. A teledermatologist was assigned to each case from a pool of 7 available adult medical dermatology faculty from the same department with experience ranging from less than 5 to more 30 years, using a random number generator.

Clinical photography

Primary teams were encouraged to obtain their own photos using a smartphone or iPad (Apple, Cupertino, CA) with the Haiku application (Epic, Verona, WI), which automatically adds the photo to the patient's electronic medical chart. If photos were not yet available, the inpatient dermatologist or a dermatology resident uploaded photos into the medical record in the same manner.

Survey

A standard survey was given to all raters (Supplemental Material; available via Mendeley at https://doi.org/10.17632/v8vyxtmdyw.1). The survey was administered to the primary team over the phone by a dermatology resident, it was completed by the inpatient dermatologist after patient assessment, and it was completed by the teledermatologist after review of the patient's chart notes, tests, and photographs. The teledermatologist was asked to blind himself/herself from all notes and test results on or after the day of dermatology consultation. Whenever possible, this was done under supervision to ensure blinding.

Data analysis

Before analysis, free-text differential diagnoses were grouped into as few distinct diagnostic categories as possible (Fig 1), accounting for differences in semantics and terminology.

Statistical methods

Diagnostic agreement between each pair of raters was assessed by using complete and partial agreement. Complete agreement was evaluated by using the single most likely diagnosis for each rater. Complete agreement was assessed using proportion of agreement between each pair of raters and the Cohen kappa statistic. Partial agreement included the differential diagnoses in addition to the most likely diagnoses. Raters were in partial agreement if any diagnoses by the raters matched. Partial agreement is reported as a simple proportion of agreement only.

Teledermatologist and inpatient dermatologist recommendations for biopsy were assessed. Proportion of agreement and the Cohen kappa were calculated.

Fig 1. Frequency counts of diagnoses by 3 raters on 53 patients. Top diagnosis (left) shows the number of patients with the most likely diagnosis by the dermatologist, hospitalist, and teledermatologist. Top and differential diagnosis (right) shows the number of times each diagnosis was selected by each rater when counting all of their differential diagnoses.

Raters were allowed to select more than 1 treatment, as shown in Fig 2. Agreement between raters is defined as exact agreement on all treatments recommended. Topical and systemic treatments were considered separately. Proportion of agreement and Cohen kappa were calculated.

Proportions of agreement and kappa statistics are reported with 95% confidence intervals (CIs); Results for kappa can be interpreted using the metric provided by Landis and Koch.[12]

RESULTS

Diagnosis

A total of 100 patients were included in the analysis. Complete data were available for 53 patients. Hospitalists declined to complete the survey in 47 cases, and the most commonly cited reason was lack of time.

Complete agreement between the dermatologist and teledermatologist was 52.8% (κ = 0.49), and partial agreement was 84.9%. Complete agreement

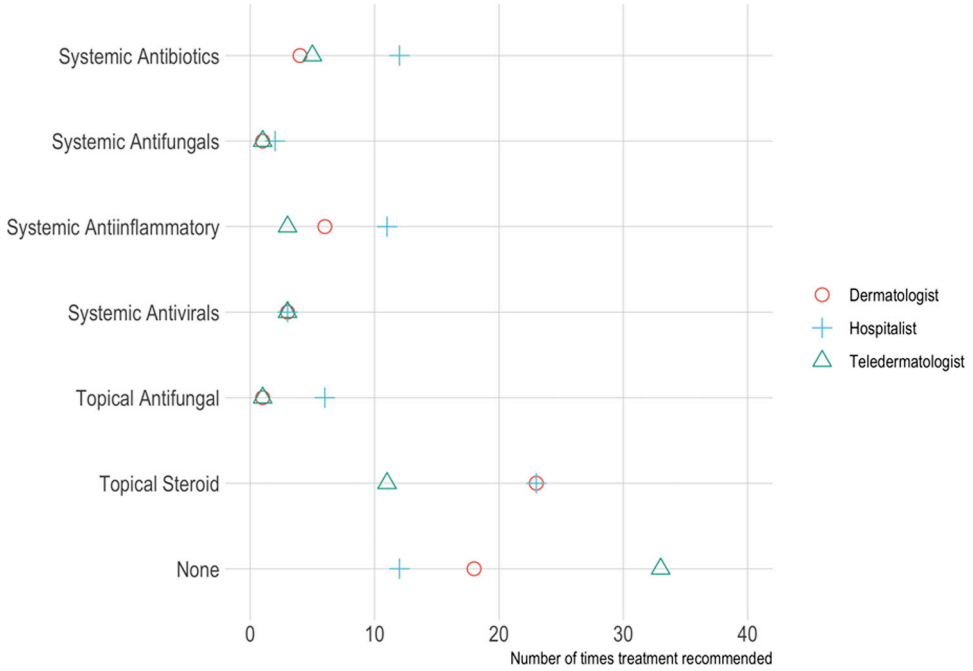

Fig 2. Frequency counts of treatment recommendation by 3 raters on 53 patients. Patients may have been prescribed more than 1 treatment.

Table I. Complete and partial agreement between each pair of raters for 53 patients

Rater pair		Complete agreement		Partial agreement
		% (95% CI)	κ (95% CI)	% (95% CI)
Teledermatologist	Dermatologist	52.8 (39.7-65.6)	0.49 (0.35-0.63)	84.9 (72.9-92.1)
Teledermatologist	Hospitalist	45.3 (32.7-58.5)	0.40 (0.27-0.54)	75.5 (62.4-85.1)
Dermatologist	Hospitalist	49.1 (36.1-62.1)	0.45 (0.31-0.59)	81.1 (68.6-89.4)

CI, Confidence interval.

between the dermatologist and hospitalist was 49.1% (κ = 0.45), and partial agreement was 81.1%. Complete agreement between the teledermatologist and hospitalist was 45.3% (κ = 0.40), and partial agreement was 75.5%. (Table I).

Treatment

For systemic treatment, agreement between the dermatologist and teledermatologist was 77.4% (κ = 0.47). Agreement between the dermatologist and hospitalist was 58.5% (κ = 0.32). Agreement between the teledermatologist and hospitalist was 52.8% (κ = 0.19) (Table II).

For topical treatment, agreement between the dermatologist and teledermatologist was 69.8% (κ = 0.38). Agreement between the dermatologist and hospitalist was 60.4% (κ = 0.29). Agreement between the teledermatologist and hospitalist was 52.8% (κ = 0.12) (Table II).

BIOPSY

The teledermatologist recommended biopsy more frequently than the dermatologist (65.5% vs 56.5%) (Fig 3). The 2 raters agreed in their biopsy recommendation for 66.0% (95% CI, 56.3-75.7) of patients. Kappa was deemed fair (0.36; 95% CI, 0.19-0.52).

DISCUSSION

There was moderate diagnostic agreement among all groups, ranging from complete agreement of 45% to 53% and partial agreement of 76% to 85%), with a trend toward highest agreement between the inpatient dermatologist and teledermatologist and the least agreement between the hospitalist and teledermatologist.

The inpatient dermatologist changed the primary diagnosis 51% of the time. This is in line with previous studies showing that inpatient dermatology changes the diagnosis approximately half of the time

Table II. Proportion agreement and kappa for topical and systemic treatment recommendations by 3 raters for 53 patients

Rater pair		Topical treatment		Systemic treatment	
		% Agree (95% CI)	κ (95% CI)	% Agree (95% CI)	κ (95% CI)
Teledermatologist	Dermatologist	69.8 (56.5 to 80.5)	0.38 (0.16 to 0.60)	77.4 (64.5 to 86.5)	0.47 (0.21 to 0.72)
Teledermatologist	Hospitalist	52.8 (39.7 to 65.6)	0.12 (−0.07 to 0.31)	52.8 (39.7 to 65.6)	0.19 (0.01 to 0.38)
Dermatologist	Hospitalist	60.4 (46.9 to 72.4)	0.29 (0.06 to 0.52)	58.5 (45.1 to 70.7)	0.32 (0.12 to 0.52)

CI, Confidence interval.

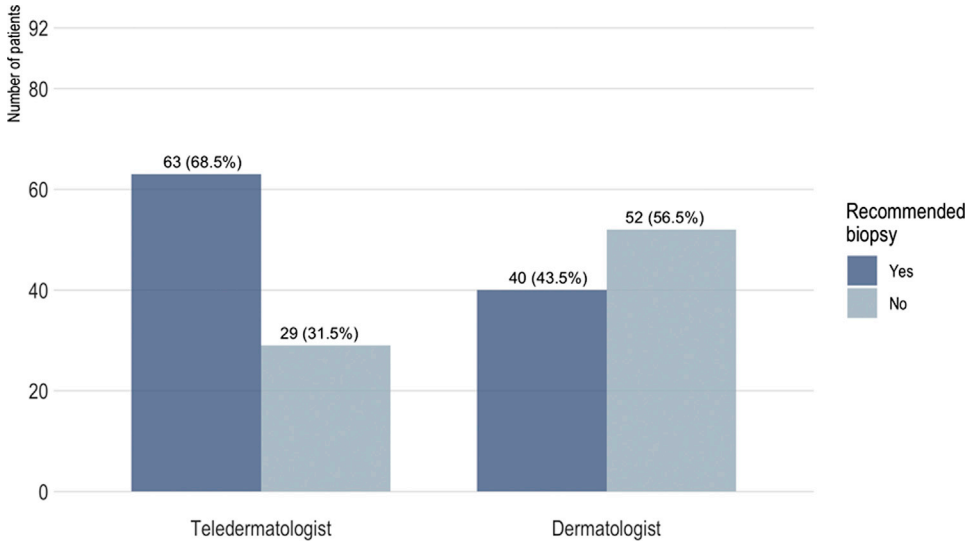

Fig 3. Proportion of patients (n = 92) for whom biopsy was recommended by the teledermatologist or dermatologist.

during the course of inpatient consultation.[6,13-16] The strength of complete and partial agreement was similar among all 3 groups. That there was 53% complete and 85% partial agreement between inpatient dermatologist and teledermatologist (highest among all comparisons) is encouraging and merits further study.

There was moderate agreement in systemic treatment recommendations between inpatient dermatologist and teledermatologist (77.4%), fair agreement in systemic treatment recommendations between the dermatologist and hospitalist (58.5%), and slight agreement in systemic treatment recommendations between the teledermatologist and hospitalist (52.8%), as interpreted by the metric of Landis and Koch.[13] Agreement regarding topical treatment recommendations was similar among all comparisons, ranging from 60% to 70%, except for only fair agreement between the hospitalist team and teledermatologist (52.8%).

The inpatient dermatologist initiated a change in topical therapy 40% of the time and a change in systemic therapy 41.5% of the time. There was greatest therapeutic agreement between the inpatient dermatologist and teledermatologist and the least between the hospitalist and teledermatologist. The inpatient dermatologist and teledermatologist agreed on systemic therapy 77% of the time, more often than either group agreed with the hospitalist (53%, 58.5%), suggesting that teledermatologists can be advantageous in recommending appropriate systemic therapy.

The findings indicate that there was fair agreement (66%) in decision to biopsy between the inpatient dermatologist and teledermatologist, with the teledermatologist recommending biopsy more often than the inpatient dermatologist. This finding may stem from greater uncertainty due to less complete assessment of the lesion or rash. It may also arise from individual provider differences in approach or the inpatient dermatologist having higher comfort with inpatient cases.

There are several limitations to the study. The inpatient dermatology arm of the study consisted almost entirely of a single provider. Differences in provider approach can confound the comparison between in-person and telemedicine modalities. Additionally, this provider specializes in hospital

dermatology; thus, agreement may have been higher if the raters in the teledermatology group also had a similar inpatient focus. Photographs were taken from a variety of sources. Hospitalists were a heterogeneous group and may have had less time to think about the questions because they were administered the survey over the phone. The project had incomplete data, most notably in the hospital arm, thus precluding 3-way comparison for nearly half of the patients. Finally, this study was executed at a tertiary center and may not be generalizable to community hospital settings.

REFERENCES

1. Sharma P, Kovarik CL, Lipoff JB. Teledermatology as a means to improve access to inpatient dermatology care. *J Telemed Telecare*. 2016;22(5):304-310.
2. Finnane A, Dallest K, Janda M, Soyer HP. Teledermatology for the diagnosis and management of skin cancer: a systematic review. *JAMA Dermatol*. 2017;153(3):319-327.
3. Piette E, Nougairède M, Vuong V, et al. Impact of a store-and-forward teledermatology intervention versus usual care on delay before beginning treatment: a pragmatic cluster-randomized trial in ambulatory care. *J Telemed Telecare*. 2017;23(8):725-732.
4. Trettel A, Eissing L, Augustin M. Telemedicine in dermatology: findings and experiences worldwide—a systematic literature review. *J Eur Acad Dermatol Venereol*. 2018;32(2):215-224.
5. Weng QY, Raff AB, Cohen JM, et al. Costs and consequences associated with misdiagnosed lower extremity cellulitis. *JAMA Dermatol*. 2017;153(2):141-146.
6. Li DG, Xia FD, Khosrav H, et al. Outcomes of early dermatology consultation for inpatients diagnosed with cellulitis. *JAMA Dermatol*. 2018;154(5):537-543.
7. Ko LN, Garza-Mayers AC, St John J, et al. Effect of dermatology consultation on outcomes for patients with presumed cellulitis: a randomized clinical trial. *JAMA Dermatol*. 2018;154(5):529-536.
8. Milani-Nejad N, Zhang M, Kaffenberger BH. Association of dermatology consultations with patient care outcomes in hospitalized patients with inflammatory skin diseases. *JAMA Dermatol*. 2017;153(6):523-528.
9. Barbieri JS, Nelson CA, James WD, et al. The reliability of teledermatology to triage inpatient dermatology consultations. *JAMA Dermatol*. 2014;150(4):419-424.
10. Muir J, Xu C, Paul S, et al. Incorporating teledermatology into emergency medicine. *Emerg Med Australas*. 2011;23(5):562-568.
11. Weig EA, Tull R, Chung J, Wanat KA. Inpatient teledermatology: current state and practice gaps. *J Am Acad Dermatol*. 2019.
12. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159-174.
13. Strazzula L, Cotliar J, Fox LP, et al. Inpatient dermatology consultation aids diagnosis of cellulitis among hospitalized patients: a multi-institutional analysis. *J Am Acad Dermatol*. 2015;73(1):70-75.
14. Galimberti F, Guren L, Fernancez AP, Sood A. Dermatology consultations significantly contribute quality to care of hospitalized patients: a prospective study of dermatology inpatient consults at a tertiary care center. *Int J Dermatol*. 2016;55(10):547-551.
15. Hu L, Haynes H, Ferrazza D, et al. Impact of specialist consultations on inpatient admissions for dermatology-specific and related DRGs. *J Gen Intern Med*. 2013;28(11):1477-1482.
16. Weinkle A, Pettit C, Jani A, et al. Distinguishing Stevens-Johnson syndrome/toxic epidermal necrolysis from clinical mimickers during inpatient dermatologic consultation—a retrospective chart review. *J Am Acad Dermatol*. 2019;81(3):749-757.