Teledermatology for Skin Cancer Diagnosis

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DISCLOSURE OF RELEVANT RELATIONSHIPS WITH INDUSTRY

Carrie Kovarik, MD
I do not have any relevant relationships with industry.
Patient presents to a primary care clinic with a challenging dermatologic condition

Primary care provider submits a teledermatology consult via a website or mobile device

Remote dermatologist reviews and responds to the consult via a website or mobile device

Primary care provider utilizes response to develop a treatment and follow up plan for the patient

New questions, responses, and updates
AADA Preferred Modalities

Live-Interactive
- Providers and patients interact via live video. A variety of peripheral hardware attachments may be utilized to enhance the consultation.

Store-and-Forward
- Sending or forwarding of digital images and associated patient data to the specialist for storage and consultation.

With pre-existing relationship both modalities can facilitate:
- Direct-to-consumer: The patient sends images or interacts live, directly with the dermatologist.
- Triage/consultative for inpatients and outpatients: Another physician sends images or interacts live with a dermatologist for either consultation or triage.
AADA Recommended Usage

- Provider to Provider
- Provider to Dedicated Telemedicine NP or PA
- Provider to Patient within a Healthcare System
- Provider to Patient already established Private Practice Setting

Source: AAD Position Statement on Teledermatology
Special Considerations: The referring and consulting providers **shall** decide whether to exclude certain types of cases that require special consideration:

- **Full body examination**: A full body skin scan using videoconferencing (VTC) or store-and-forward (S&F) is feasible, but it **may** not show all skin lesions and surfaces with sufficient detail. Enhanced lighting, multiple imaging and several angles **may** be helpful.

- **Hair-bearing skin**: The scalp and other areas with a significant amount of hair **may** need to have hair physically displaced or removed, and special lighting **may** enhance viewing conditions.

- **Pigmented lesions**: Pigmented lesions **may** present a diagnostic challenge and **should** require a higher index of suspicion when interpreting. Peripheral devices such as dermoscopes and confocal microscopy **may** be incorporated into teledermatology consultations (1, 27, 50, 74).
Patients visiting 5 participating primary care centers because of concern over lesions suggestive of skin cancer were randomized to clinical teleconsultation (CTC) or CTC + dermatoscopic exam.

The **addition of dermoscopic images significantly improved the results** of an internet-based skin cancer screening system, compared with screening systems based on clinical images alone.
### Table III. Diagnostic performance of clinical and dermoscopic teledermatology

<table>
<thead>
<tr>
<th></th>
<th>CTC</th>
<th>DTC</th>
<th>P</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>86.57%</td>
<td>92.86%</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>82.12%-91.02%</td>
<td>89.52%-96.2%</td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>72.33%</td>
<td>96.24%</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>66.5%-78.16%</td>
<td>93.77%-98.71%</td>
<td></td>
</tr>
<tr>
<td>False-negative rate</td>
<td>13.43%</td>
<td>7.14%</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>8.98%-17.88%</td>
<td>3.8%-10.48%</td>
<td></td>
</tr>
<tr>
<td>False-positive rate</td>
<td>22.16%</td>
<td>3.76%</td>
<td>.001</td>
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<tr>
<td></td>
<td>16.75%-27.57%</td>
<td>1.29%-6.23%</td>
<td></td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>56.98%</td>
<td>84.38%</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>50.53%-63.43%</td>
<td>79.67%-89.09%</td>
<td></td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>92.86%</td>
<td>98.17%</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>89.5%-96.22%</td>
<td>96.43%-99.91%</td>
<td></td>
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<tr>
<td>Accuracy index</td>
<td>79.20%</td>
<td>94.30%</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>73.91%-84.49%</td>
<td>91.29%-97.31%</td>
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</table>

Ranges expressed correspond to CIs.  
*CI, Confidence intervals; CTC, clinical teleconsultation; DTC, clinical and dermoscopic image-based teledermatology.*

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**Fig 1.** Clinical and dermoscopic teleconsultation.  
A. Up to 2 to 3 clinical images and 1 to 2 dermoscopic images are used in dermoscopic teleconsultations.  
B. Detail of a high-quality dermoscopic image of a clear-cut seborrheic keratosis managed through teledermoscopy.
Teledermoscopy is considered a reliable tool for the evaluation of pigmented skin lesions in the correct context.

Study compared management decisions in FTF visits vs. teledermatology in a high-risk melanoma cohort using TBP, macroscopic and dermoscopic images of single lesions. Patients assessed by both FTF & by 4 remote teledermatologists. Lesions identified as suspicious by FTF evaluation underwent surgical excision. Teledermatologists rec “self-monitoring”, “short-term monitoring”, or “excision”. 4-year monitoring was completed - calculation showed almost perfect agreement (PABAK 0.9–0.982). A total of 23 lesions were excised; all teledermatologists identified the 9 melanomas.
Fig. 2. Melanoma in a 50-year-old woman, which was recommended for excision by all attending dermatologists. Histopathology showed a highly suspicious melanocytic lesion, which was eventually diagnosed as melanoma (Breslow thickness 0.9 mm). (a) Brown papule on the right shoulder. (b) Macroscopic image of a 5-mm reddish brown papule with a shiny surface. (c) Dermoscopic image of lesion (b). Inhomogeneous pigmentation with a greyish patch comprising irregular dots/globules with a delicate blue-whitish veil. Note the irregular network on the right-hand side.
**Objective:** To assess the feasibility, efficacy, and patient receptivity of teledermoscopy for short-term monitoring of clinically atypical nevi.

- Dermoscopic images were obtained by a dermatologist and with iPhone by patients at baseline and 3-4 months.
- Standard *dermoscopic images* were evaluated by the office-based dermatologist, and mobile dermoscopic images were sent to teledermatologist to evaluate for change.
- Decisions of teledermatologist & office-based dermatologist were compared.
A and B. Images from patient 1 at initial and follow-up visits, respectively; no significant change was observed. C and D. Images from patient 2 at initial and follow-up visits, respectively; a significant change was observed.
• Of 29 patients, 28 were able to acquire baseline and follow-up images that were deemed evaluable by the teledermatologist.

• *Diagnostic concordance* between conventional office-based visits & teledermoscopy encounters was 0.87 (SE, 0.13) (κ statistic).

• Pts reported *high receptivity* to teledermoscopy for monitoring of nevi.

• Results suggest that teledermoscopy is *feasible and effective* as a method for short-term monitoring of clinically atypical nevi.

• Implementation of teledermoscopy can potentially enhance patient convenience, optimize physician scheduling, and *promote efficiency*.
• 50–64 year olds at high risk of melanoma
• 49 pts with smartphones were sent instructions/equipment to conduct mobile teledermoscopy in their homes
• 87% agreed that mobile teledermoscopy would improve their skin self-examination performance
• However, nearly half were unsure about whether they had complete trust in the telediagnosis.
• Participants reported that dermatoscope was easy to use (94%) however, 18% could not take photos in hard-to-see areas and 35% required help to submit the photographs.

• Participants expressed concern about lack of training & inability to find most relevant lesions.

• Many experienced anxiety during the period of waiting for a telediagnosis – and its vital to ensure correct follow up and care.
# Table 5. Summary of Recommendations for Teledermatology for the Diagnosis and Treatment of Skin Cancers

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Grade of Recommendation</th>
<th>Quality of Evidence</th>
<th>Source</th>
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<tbody>
<tr>
<td>Teledermatology should be used for patients where it is not feasible to provide FTF consultation.</td>
<td>2A</td>
<td>B</td>
<td>Borve et al., 2012; Borve et al., 2013; Borve et al., 2015; Boyce et al., 2011; Conahton et al., 2011; Kroemer et al., 2011; Lamel et al., 2012; Manahan et al., 2013; Massone et al., 2014; Senel et al., 2014; Silveira et al., 2014; Tan et al., 2010; Tan et al., 2010; Van der Heijden et al., 2013; Warshaw et al., 2015; Wolf et al., 2013</td>
</tr>
<tr>
<td>Teledermatology can be used as a triage tool to reduce waiting times to assessment.</td>
<td>2A</td>
<td>B</td>
<td>Ferrandiz et al., 2012; Lim et al., 2012; Morton et al., 2010; Borre et al., 2015</td>
</tr>
<tr>
<td>Currently available technology is suitable for teledermatology assessment. Training of clinicians and consumers and/or patients should be considered to improve image quality.</td>
<td>1</td>
<td>B</td>
<td>Boyce et al., 2011; Wolf et al., 2013; Silveira et al., 2014; Borve et al., 2013; Van der Heijden et al., 2013; Massone et al., 2014; Manahan et al., 2015; Warshaw et al., 2015; Wu et al., 2015</td>
</tr>
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</table>

**Abbreviation:** FTF, face-to-face.
* Graded according to criteria by Robinson et al. Grade of recommendation: 1, strong recommendation: high-quality, patient-oriented evidence; 2A, weak recommendation: limited-quality, patient-oriented evidence; 2B, weak recommendation: low-quality evidence. Quality of evidence: A, systematic review/meta-analysis, randomized clinical trials with consistent findings, all-or-none observational studies; B, systematic review/meta-analysis of lower-quality clinical trials or studies with limitations and inconsistent findings, lower-quality clinical trial, cohort study, case-control study; C, consensus guidelines, usual practice, expert opinion, case series.
• Few studies (4/21) assessed health services outcomes measures - those that did found the use of teledermatology could:
  – Reduce waiting times
  – Result in earlier assessment and treatment
  – Lead to high patient satisfaction and willingness to pay out of pocket for access to services.

• Diagnostic difficulty
  – Levels of diagnostic agreement were related to clinician-reported diagnostic confidence.
  – More experience with teledermatology cases may increase confidence and improve accuracy.

• No studies assessing longer-term outcomes like quality of life or workflow that were specific to skin cancer and eligible for inclusion.
Deep convolutional neural networks (CNNs) show potential for classification of skin lesions using a single CNN, trained end-to-end from images directly, using only pixels/disease labels as inputs.

Authors train a CNN using a dataset of 129,450 clinical images, with 2,032 different diseases.

Tested performance against 21 board-certified dermatologists on biopsy-proven clinical images with two critical binary classification use cases: keratinocyte carcinomas versus benign seborrheic keratoses; and MM versus benign nevi.
Figure 2 | A schematic illustration of the taxonomy and example test set images. 

a. A subset of the top of the tree-structured taxonomy of skin disease. The full taxonomy contains 2,032 diseases and is organized based on visual and clinical similarity of diseases. Red indicates malignant, green indicates benign, and orange indicates conditions that can be either. Black indicates melanoma. The first two levels of the taxonomy are used in validation. Testing is restricted to the tasks of benign and malignant.

b. Malignant and benign example images from two disease classes. These test images highlight the difficulty of malignant versus benign discernment for the three medically critical classification tasks we consider: epidermal lesions, melanocytic lesions and melanocytic lesions visualized with a dermoscope. Example images reprinted with permission from the Edinburgh Dermofit Library (https://licensing.eri.ed.ac.uk/i/software/dermofit-image-library.html).
Authors conclude this is a **scalable** and deployable technology on mobile devices and holds the potential for substantial clinical impact, including broadening the scope of primary care practice and augmenting clinical decision-making for dermatologists.

Further research is necessary to evaluate performance in a real-world, clinical setting, in order to **validate this technique** across the full distribution and spectrum of lesions encountered in typical practice.

Authors acknowledge that a dermatologist’s clinical impression and diagnosis is **based on contextual factors** beyond visual and dermoscopic inspection of a lesion in isolation.

However, they also mention the ability to classify skin lesion images with the accuracy of a dermatologist has **potential to profoundly change care**.
Take a picture, Analyse, Track changes

1. Take a picture
Hold the device over a mole or skin condition and take a picture.

TRY IT NOW

2. Analyse
The app will analyse the spot in an instant and give you a recommendation

GET STARTED
Conclusions: The performance of smartphone applications in assessing melanoma risk is highly variable, and 3 of 4 smartphone applications incorrectly classified 30% or more of melanomas as un concerning. Reliance on these applications, which are not subject to regulatory oversight, in lieu of medical consultation can delay the diagnosis of melanoma and harm users.

Section Two. Establishing the Physician-Patient Relationship

- The health and well-being of patients depends upon a collaborative effort between the physician and patient. The relationship between physician and patient is complex & is based on mutual understanding of the shared responsibility for a patient’s health care.

- Although the Board recognizes that it may be difficult in some circumstances to precisely define the beginning of the physician-patient relationship, particularly when the physician and patient are in separate locations, it tends to begin when an individual with a health-related matter seeks assistance from a physician who provides assistance.
MODEL POLICY FOR THE APPROPRIATE USE OF TELEMEDICINE TECHNOLOGIES IN THE PRACTICE OF MEDICINE

Report of the State Medical Boards’ Appropriate Regulation of Telemedicine (SMART) Workgroup

Adopted as policy by the Federation of State Medical Boards in April 2014

Establishment of a Physician-Patient Relationship:
Where an existing physician-patient relationship is not present, a physician must take appropriate steps to establish a physician-patient relationship consistent with the guidelines identified in Section Two, and, while each circumstance is unique, such physician-patient relationships may be established using telemedicine technologies provided the standard of care is met.

Evaluation and Treatment of the Patient:
A documented medical evaluation and collection of relevant clinical history commensurate with the presentation of the patient to establish diagnoses and identify underlying conditions and/or contra-indications to the treatment recommended/provided must be obtained prior to providing treatment, including issuing prescriptions, electronically or otherwise. Treatment and consultation recommendations made in an online setting, including issuing a prescription via electronic means, will be held to the same standards of appropriate practice as those in traditional (encounter in person) settings. Treatment, including issuing a prescription based solely on an online questionnaire, does not constitute an acceptable standard of care.
Negligence

"Negligence is the omission to do something which a reasonable man, guided upon those considerations which ordinarily regulate the conduct of human affairs, would do, or doing something which a prudent and reasonable man would not do." [91].

A plaintiff seeking to establish negligence must prove:

1. That the tele-doctor owed the patient a duty of care
2. That the duty was breached, that is, the tele-doctor was careless
3. That the patient suffered harm as a consequence of that carelessness.

In addition, a basic principle of tort law states that no cause of action for negligence exists unless the defendant/doctor owes a legal duty to the plaintiff/patient. A doctor had a duty to exercise a reasonable degree of learning and skill but only if a doctor-patient relationship exists.

The doctor-patient relationship is established only with the consent of both doctor and patient. Traditionally, informal consultations in which the doctor discusses the patient's medical history and current condition with colleagues does not establish a doctor-patient relationship as a result of those discussions. With respect to telemedicine, the patient, doctor and tele-consultant can all be present at the same time with the consultation being rendered both with the patient's consent and on the behalf of that patient. Under these circumstances, the courts will determine that a doctor-patient relationship has been established via the electronic medium. Once this is established, the tele-consultant has a duty to act within the parameters of the standard of care.
Assessment of smartphone applications for total body digital photography-guided skin exams by patients

Andrew J. Marek, MS, Emily Y. Chu, MD, PhD, Michael E. Ming, MD, MSCE, and Carrie L. Kovarik, MD

Feasibility and Efficacy of Patient-Initiated Mobile Teledermoscopy for Short-term Monitoring of Clinically Atypical Nevi

Xinyuan Wu, BA; Susan A. Oliveria, ScD; Sarah Yagerman, MD; Lucy Chen, MD; Jennifer DeFazio, MD; Ralph Braun, MD; Ashfaq A. Marghoob, MD

Internet-based skin cancer screening using clinical images alone or in conjunction with dermoscopic images: A randomized teledermoscopy trial

Lara Ferrándiz, MD, PhD, Teresa Ojeda-Vila, MD, PhD, Araceli Corrales, MD, Francisco J. Martín-Gutiérrez, MD, Andrés Ruiz-de-Casas, MD, Rafael Galdeano, MD, Igualco Álvarez-Torralba, NP, Francisco Sánchez-Ibáñez, NP, José M. Domínguez-Toro, NP, Fernando Encina, NP, Francisco J. Narbona, MD, Juan M. Herrera-Esteban, MD, and David Moreno-Ramirez, PhD, MD

Seville, Spain

http://www.canadianskincancerfoundation.com
Questions?