Future developments in teledermoscopy and total body photography

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Introduction

The development and increasing popularity of dermoscopy in recent decades has helped dermatologists and primary care providers to improve the diagnosis of skin lesions, especially skin tumors, and more recently inflammatory lesions as well. Dermoscopy can now be used not only for diagnosis, but also to monitor the course of the disease and response to treatment for disorders as diverse as carcinomas, rosacea, psoriasis, lupus erythematosus, and porokeratosis[1]. More recently still, teledermoscopy has expanded the reach of this useful technology, by using a digital dermoscope or standard digital camera with a dermoscopic lens attachment to capture images and send them to a teleconsultant. A variety of teledermoscopy platforms are available off the shelf, and can also be adapted to the organization’s particular needs.

Teledermoscopy is a particularly valuable tool due to its visual nature, especially for clinicians and their patients in rural or remote areas, where face-to-face appointments can be difficult to arrange. The teleconsultant replies at a time suitable for them, often within 24 hours, with a provisional diagnosis and a course of action for the local treating clinician. In fact, including dermoscopic images in a teleconsultation improves accuracy while only adding one to two minutes to the consultation[2]. Diagnostic accuracy is less dependent on image quality than on the expertise of the teleconsultant and the diagnostic difficulty of the lesion. Two systematic reviews found that diagnostic accuracy was somewhat lower for teledermatology than face-to-face appointments, but adding teledermoscopy improves diagnostic accuracy considerably[3-4].

Another important use of teledermoscopy in large health systems, such as those of China and the USA, is triaging more urgent cases for face-to-face appointments with a dermatologist. Several studies found that teledermoscopy can be more efficient than traditional paper referrals in arranging quick review of high-priority patients[5], by ruling out melanoma or keratinocyte cancers, it can also reduce the number of unnecessary referrals for face-to-face dermatology appointments, freeing up time for more urgent cases. Patients report high satisfaction with teledermoscopy, as it increases their privacy and comfort and reduces waiting times[6].

Teledermoscopy can also be a useful tool for educating beginner dermatoscopists, who can send a difficult lesion to a more experienced colleague for a second opinion. Primary care providers can also make use of teledermo-
scopy consultations with specialist dermatologists to improve their understanding of lesion types that they see rarely. Some difficulties remain in integrating teledermoscopy into regular practice. Among the most pressing are assigning medico-legal responsibility for the patient, especially if the referring physician and consultant are in different jurisdictions, setting up a system for reimbursement of teleconsultants, integrating patient images into existing electronic health records, and instituting privacy and security features for patient images and information. However, several health systems, such as Australia, the Netherlands, and the USA, have begun integrating teledermoscopy into their regular systems, and their example can provide guidance for health systems that wish to make the most of teledermoscopy.

**Mobile teledermoscopy**

Mobile teledermoscopy, performed with a polarized light dermoscopic lens adapted to be attached to a standard smartphone, allows clinicians or patients themselves to take dermoscopic images in any location with mobile phone coverage and forward them for expert assessment, usually with an app or a dedicated website. Users ranging from high school students to primary care providers require only basic instruction to take adequate mobile teledermoscopy images. Mobile teledermoscopy is particularly useful in areas where traditional teledermatology infrastructure is lacking. In developing countries, the mobile phone network is often more reliable than other electronic communications and can present a relatively low-cost way to extend dermatological expertise into rural and remote areas.

Up to half of all malignant lesions are first noticed by the patient or their partner, a statistic mobile teledermoscopy may be able to harness to improve early detection rates. Study participants report that self-imaging is easy to perform and motivates them to inspect their own skin for potentially cancerous lesions more often. Likewise, mobile teledermoscopy enables patients to perform follow-up monitoring and send images to their dermatologist, reducing the number of face-to-face follow-up appointments needed. However, self-teledermoscopy can be difficult to perform thoroughly when the patient has many pigmented skin lesions, does not have a partner to assist with difficult-to-reach areas like the back, or has not been educated about which lesions require attention. Janda *et al.* are currently performing a randomized trial of over 200 participants, comparing the lesions patients select for further investigation via traditional skin self-examinations (SSE) to lesions patients select with SSE with a mobile dermoscope, and with lesions selected by a dermatologist during an in-person clinical skin examination.

Focus group participants report interest in monitoring their own lesions with a mobile dermoscope, with 95% interested in being able to send an image via mobile teledermoscopy to their dermatologist, but would prefer to do this between regular face-to-face appointments. Australian studies suggest that patients are prepared to pay for direct-to-consumer mobile teledermoscopy services, especially those that have a dermatologist review the images, while dermatologists’ remuneration expectations for store-and-forward teledermatology are in line with patients’ willingness to pay. Like the patients, dermatologists preferred face-to-face consultations that allowed full-body examinations, but most agreed that teledermoscopy was useful where face-to-face appointments were not possible.

**Total body dermoscopy**

Total body photography (TBP) and sequential digital dermoscopic imaging (SDDI) are imaging modalities that are often combined for maximum usefulness. As the name suggests, TBP aims to capture images of the patient’s whole skin at each visit, although in practice some areas are not usually imaged, such as the soles of the feet, parts of the scalp covered by hair, and genitals. 2D TBP uses a series of 2D images in a variety of postures, while 3D TBP uses software to stitch together images from dozens of 2D cameras that image the patient at the same time from multiple angles to form a 3D representation of the skin. SDDI involves taking dermoscopic images of the same mole at each visit, allowing them to be compared for subtle changes over time. Several platforms allow TBP and SDDI to be combined, allowing a lesion on the overview images to be digitally connected to all the dermoscopic images of it.

Since change over time is a highly sensitive marker of malignancy, TBP and SDDI are able to improve the benign-to-malignant excision ratio, reducing morbidity caused by unnecessary excisions while improving early detection of malignancies. Another major strength of TBP is that it builds a picture of the patient’s normal mole phenotype, making the “ugly duckling” moles easier to identify, especially in patients with many dysplastic moles. Manually
imaging each lesion can take 30 to 90 minutes, limiting the practical usefulness of this kind of imaging, but new technologies now allow TBP with polarized light in seconds, with artificial intelligence selecting skin lesions for closer inspection. Standardized body postures and lighting is necessary for comparing images across multiple visits, and systems use laser positioning or floor mats with foot positions to assist this. 3D devices have difficulty imaging hair and sometimes patterns on any clothing the patient is wearing, such as polka dots on underwear; however, development continues to make headway against these obstacles.

As an emerging technology, TBP systems are still expensive, often require extensive floor space, and are not usually covered by medical insurance. However, as trials are underway to assess the clinical and health economics value of such systems, they are likely to become more available and popular in the future\(^{(17)}\).

**Artificial intelligence**

Given the capacity of computers to analyze far more data than humans, artificial intelligence (AI) is a promising area for information-rich teledermoscopy images. Under ideal conditions, AI can already outperform expert dermatologists at diagnosing skin cancers from images alone\(^{(18-19)}\). However, challenges remain for the use of AI on common, less-than-ideal images, such as those with hair, lesions with ambiguous borders, and areas with extensive sun damage. In these cases, segmentation of the image into lesion and non-lesion areas must initially be done by human experts, and is time-consuming and subjective. Access to larger repositories of both benign and malignant lesion images will help developers solve these problems, as well as discovering what is the minimum metadata needed to diagnose lesions reliably.

However, clinicians will need to guard against unintended consequences of introducing AI into the dermatology clinic, most importantly the deskilling of clinicians from overreliance on automated systems. Such overreliance can reduce a clinician’s ability to interpret signs, symptoms and other clinical data and can lead to severe service interruptions if the automated system breaks down.

**Conclusions**

Teledermoscopy has proven useful both as a triage tool for busy urban dermatology practices and for extending dermatological services to remote or underserved areas, as well for continued training for novice dermoscopists. Its reach has been improved by
the advent of mobile teledermoscopy, total body photography and sequential digital dermoscopic imaging, allowing the full range of a patient’s lesions to be examined and compared over time, which improves the sensitivity and specificity of dermoscopy still further. Finally, the information-rich images of teledermoscopy are fertile ground for artificial intelligence algorithms, which is likely to become a useful analytical tool for teledermoscopists in the very near future.

References

Cite this article as: Lee KJ and Soyer HP. Future developments in teledermoscopy and total body photography. Int J Dermatol Venereol, 2019,2(1):15-18.