Cutting Edge Technology in Dermatology: Virtual Reality and Artificial Intelligence

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The clinical practice of dermatology is changing at a rapid pace. Advances in technology and new inventions in rapid diagnostics are revolutionizing how physicians approach medical care. In 2009, the Health Information Technology for Economic and Clinical Health Act of 2009[1] ushered in the era of electronic medical records, along with a series of associated challenges.[2] In 2014, the potential reach of medical expertise in the United States was expanded with the creation of the Interstate Medical Licensure Compact, which offers an expedited pathway to licensure for physicians seeking to practice in multiple states as a way to increase access to health care in underserved or rural areas via telemedicine.[3] In early 2017, a computer algorithm was able to perform on par with board-certified dermatologists when distinguishing between clinical images of biopsy-proven benign and malignant skin lesions.[4] Recently, Microsoft announced a partnership with rural telecommunications providers to bring high-speed broadband Internet service to millions of Americans using television white space technology, which can improve access to health care services through the implementation of telemedicine and other connected health technologies in rural communities.[5]

Given these advances, how does today's dermatologist integrate into the future of the specialty? If leveraged properly, current technologies such as teledermatology and patient portals integrated with electronic medical records can be beneficial to dermatology practices by improving access to care, facilitating triage of patients, and improving communication between patients and health care team members. Herein, we discuss some of the emerging technologies that have the potential to shape clinical dermatology practice and remove barriers to care.

Virtual Reality

Teledermatology can be practiced through live video or, more commonly, via a store-and-forward method in which dermatologists review clinical photographs and the patient's history asynchronously with the in-office visit.[6] Virtual reality has the potential to augment teledermatology services by enabling a live, interactive visit that more closely models the traditional face-to-face visit. Virtual reality already is available for patients at home with the use of a commercially marketed headset and a smartphone, and the marriage of virtual reailty and telemedicine has the potential to transform health care.

Virtual reality also can be used to deliver an essential component of the physical examination of a patient: sensory information from palpation. Haptic feedback, also known as haptics, is used to relay force and tactile information to the user of a device (eg, a haptic glove).[7] In dermatology, this information pertains to the skin texture, skin profile, and physical properties (eg, stiffness, temperature).[8] Assessing the texture of the skin surface can help when distinguishing epidermal processes such as psoriasis versus atopic dermatitis or when evaluating edema, induration, and depth of a leg ulcer.[9]

One model for conducting a teledermatology encounter that captures sensory information would consist of a haptic probe located at a referring medical provider's office for examining patients and a master robot that controls the probe located at the consulting dermatologist's facility.[8] Another model converts 2-dimensional images taken from traditional full-body optical imaging systems into virtual 3-dimensional (3D) images that can be felt using a haptic device.[10,11] In this method, the user is able to both visualize and touch the skin surface at the same time. Currently, 3D imaging of skin lesions is available in the form of a

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specialized handheld imager that allows the dermatologist to appreciate the texture and elevation of single lesions when viewing clinical photographs. Additionally, full-body 3D mapping of the skin surface is available for monitoring pigmented lesions or other diseases of the skin.[12,13]

Artificial Intelligence and Machine Learning

Computer algorithms can be helpful in assisting physicians with disease diagnosis. Machine learning is a subfield of artificial intelligence (AI) in which computer programs learn automatically from experience without explicit programming instructions. A machine learning algorithm uses a labeled data set known as a training set to create a function that can make predictions about new inputs in the future.[14] The algorithm can successively compare its predicted outputs with the correct outputs and modify its function as errors are found; for example, a database of images of healthy skin as well as the skin of psoriasis patients can be fed into a machine learning algorithm that picks up features such as color and skin texture from the labeled photographs, allowing it to learn how to diagnose psoriasis.[15]

In one instance, researchers at Stanford University (Stanford, California) used approximately 130,000 images representing over 2000 different skin diseases in order to train their machine learning algorithm to recognize benign and malignant skin lesions.[4] Although the algorithm was able to match the performance of experienced dermatologists in many diagnostic categories, further testing in a real-world clinical setting still needs to be done. In the future, nondermatologists may have the option to consult with decision-support systems that include image analysis software, such as the one developed at Stanford University, for making decisions in triage or diagnosis, which may be critical in areas where access to a dermatologist is limited.[4] Future AI systems also may provide supplemental assistance in managing patients to dermatology trainees until they have the experience of a more established dermatologist.

Currently, AI cannot match general human intelligence and life experience; therefore, physicians will continue to make the final decisions when it comes to diagnosis and treatment. In the future, AI algorithms may integrate into clinical dermatology practice, leading to more accurate triage of lesions, potentially streamlined referral to dermatologists for skin conditions that require prompt consultation, and improved quality of care.

Summary

In conclusion, emerging technologies have the power to augment and revolutionize dermatology practice. Savvy dermatologists may incorporate new tools in a way that works for their practice, leading to increased efficiency and improved patient outcomes. Eventually, the technology that is most beneficial to clinical practice will likely be adopted by and integrated into mainstream dermatologic care, making it available for the majority of clinicians to use.

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