Will machines replace dermatologists in the diagnosis of skin disease?

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Introduction

With recent advances in artificial intelligence (AI), not a week goes by without an article with a catchy headline stating that a certain medical specialty will soon be replaced by "robots". But are such claims substantiated? In this essay, I hope to explore this fascinating topic by firstly, reviewing recent literature on the role of AI technologies such as deep learning convolutional neural networks (CNNs) in the diagnosis of dermatological disease. Secondly, I will outline some of the existing technologies that aim to complement contemporary dermatologic practices. Some examples of this include teledermatology, mobile dermoscopy/dermatoscopy, and smartphone apps. Finally, I will briefly discuss patient-centred care as relevant to AI in dermatology. Throughout the essay, I will draw on some relevant personal experiences both as a student doctor and as a patient, to hopefully, provide the reader with additional context from my perspective. Due to the concerningly high rates, and thus, the public health importance of melanoma in New Zealand,[1] as well as the breadth of the topic, for the purposes of this entry I am going to focus on the use of AI and other technological tools in detection of melanocytic cancer specifically. At the same time, I will also acknowledge that AI and technology may be successfully utilised to diagnose other types of skin disease, too.

Recent advances of AI and machine learning in dermatology

As alluded to in the introduction, of particular interest to dermatology is the concept of deep learning CNNs. CNNs are artificial, feed-forward neural networks capable of analysing and learning from visual imagery.[2,3] CNNs are able to improve their future performance according to their previous experiences in image recognition and classification – this process is referred to as machine learning.[2,3] The concept of CNNs has become especially topical after the results of a study by Esteva et al were published in *Nature* last year.[4] In this landmark study (the largest of its kind), over 100,000 biopsy-backed clinical photographs were used to teach a deep learning CNN-based algorithm to discern malignant skin lesions from their benign mimickers.[4] When asked to differentiate between, firstly, melanomas and benign naevi, and, secondly, keratinocyte (i.e. non-melanocytic) carcinomas and seborrheic keratoses, the CNN system performed comparably to a cohort of 21 board-certified dermatologists.[4] For the first time, successful utilisation of a computer algorithm capable of expert level thinking was demonstrated for a relatively subjective task, which is of increasing importance in everyday dermatological practice.

Less than a year later, Haenssle et al reported that a deep learning CNN that was trained specifically to distinguish dermatoscopic images of benign and malignant melanocytic lesions has shown to be, on average, superior in both sensitivity and specificity when compared to an international panel of 51 dermatologists.[6] More than half of those physicians were considered experts with five plus years of dermatoscopic experience.[6] When additional clinical information was provided to the dermatologists (to simulate the real life setting more closely), their overall sensitivity was improved, yet the algorithm still outperformed clinicians in terms of specificity.[5] Therefore, it was suggested that a competently trained CNN may be a helpful addition to any dermatologist's diagnostic toolbox, regardless of their level of expertise.[5,6]

Earlier this year, I had the privilege of attending and presenting at the New Zealand Dermatological Society Incorporated annual conference. Two of the scheduled sessions addressed the topic of machine learning and AI in melanoma diagnosis. These talks, which heavily featured data from the two studies described above, stimulated heated discussion among dermatologists. It soon became obvious that, at present, even local experts may not necessarily be able to reach an agreement; some were sceptical about the technical abilities of AI or expressed concerns regarding patient satisfaction, whereas others warmly welcomed the idea of incorporating CNN systems into their practice, provided it reliably results in fewer missed cancerous lesions and misdiagnosed benign ones.

While, understandably, there is a considerable amount of excitement surrounding CNN, the tangible benefits of the demonstrated accuracy and efficiency of this technology may still be distant.[4–6] This is because initial CNN training requires a substantial amount of resources and time, and actual implementation into routine clinical practice is only possible once local medico-legal boundaries are better defined, and security risks are addressed.[4–6]

Other technology for the most visual specialty

It has been postulated that because of the highly visual nature of diagnosis and management of skin conditions, modern technology constitutes an especially valuable addition to dermatology – perhaps, even more so than any other medical specialty.[7,8] The number of now routine dermatological practices that heavily rely on machines of various kinds (not necessarily AI based) for visual assessment of skin disease in one form or another is vast; among them are whole-body photography, dermatoscopy, and teledermatology.

Given the recent surge of interest in healthcare-related technology, it is not surprising that personal electronic devices are being increasingly utilised by healthcare professionals.[7,8] Indeed, I have personally witnessed numerous dermatologists regularly utilising their mobile phones in their everyday practice, whether to quickly access reputable reference sources (such as DermNet NZ), or to use convenient smartphone dermoscope attachments, which are becoming increasingly popular. Not to mention conventional dermoscopy, which can be considered the gold standard of clinical dermatologic assessment today.[7,8]

With the rise of telemedicine, mobile devices and computers are now becoming increasingly important for patients with skin problems, too, especially those who may struggle to access in-person dermatology advice (for example, individuals from rural/remote or low socioeconomic status communities).[9,10] While both the store-and-forward and live interactive forms of teledermatology have limitations (such as security issues or inability to incorporate palpation, a core component of skin examination), research suggests that, overall, teledermatology is a promising way of efficiently delivering quality dermatological care at a lower cost compared to face-to-face visits.[8–11]

Smartphone applications

Over the last couple of years, countless smartphone applications and internet websites that aim to educate, diagnose, or even help manage various health conditions have become available to both the general public and the physician community.[12,13] Among the more popular are apps designed specifically to help consumers detect malignant skin lesions, especially melanomas, at home.[14–18] Some of these are designed to be more of a triage tool, whereas others virtually aim to replace a dermatologist's consult; most have ambiguous legal/regulatory status.[14–18] Because of heterogeneity in the software employed in such apps and in their purpose, the diagnostic accuracy, and thus, practical utility of this class of apps as a whole is difficult to evaluate.[14–18] According to a large 2018 systematic review conducted by Rat et al, automated smartphone medical apps aimed at melanoma diagnosis are currently considered to be unreliable from accuracy and safety standpoints.[18] Issues commonly reported in the literature include unacceptable rates of false positive results, which could result in unwarranted patient anxiety and increase in demand for unnecessary specialist care, as well as high false negative rates and thus missed opportunities for timely identification and treatment of potentially dangerous skin lesions due to false reassurance.[14–18] The latter especially raises the complex issue of medico-legal liability.[18] Regardless, these tools remain a popular conversation topic among patients: during my time as a student attached to Dermatology and General Practice clinics, discussions around "self-assessment" skin-check apps were a near everyday occurrence.

Way forward

Clearly, considerable efforts to improve melanoma-detecting apps are required before they can become appropriate and widely accepted alternatives for proper clinical skin specialist consultations.[14–18] However, with the impressive results achieved by Esteva and Haennsle using deep neural networks in mind, it is not unreasonable to infer that if similar CNN technology could be competently trained and incorporated into a user-friendly phone application, it would represent a major step forward for skin cancer-detecting apps from a diagnostic accuracy standpoint.[4–6,18] It would also be interesting to observe the future interplay of the fields of whole-body photography, mobile dermoscopy, teledermatology, and modern AI. A successful fusion of these technologies could facilitate the diagnostic process even further and benefit everyone involved in the detection and treatment of skin cancer, from patients to experts.[5,6,8,14] Uncertainty regarding dermatological diagnoses is prevalent among primary care practitioners: despite dedicating large amounts of clinical time to patients with skin complaints, many general practitioners lack formal dermatological training and/or expertise.[19] Thus, the advent of such CNN-based tools for the purposes of decision-making support could be very helpful in the community setting as it could improve system efficiency and reduce the burden of unnecessary referrals to specialists.[5,19] Dermatologists that currently look after high-risk patients would also benefit from AI-based apps due to a streamlined, targeted surveillance process, while patients themselves may enjoy the enhanced convenience and reliability of self-skin checks.[5,12,13]

Touch and empathy versus technology

Finally, I wanted to touch on some of the more philosophical aspects of the interplay between technology and doctor-patient relationships by reflecting on my own recent experience. I was a patient evaluated and treated for a pigmented skin lesion suspicious for malignancy. Without going into too much detail, it was a drawn-out, stressful affair comprised of long periods of waiting and uncertainty, multiple referrals, appointments, and, finally, surgery. This process could probably be vastly simplified, had the timely utilisation of technology such as CNN been possible. However, despite being inefficient and frustrating at times, the overall experience ended up being memorable in a good way because of the wonderful advice, respect, empathy, and reassurance offered by the doctors I encountered on my journey as a patient. At the time of writing this, I still do not know the result of the biopsy, but I do know that, no matter the histological outcome, personally I would not have traded the excellent in-person care I received for a quicker, definitive diagnosis made by a computer algorithm.

Upon reviewing relevant literature, I discovered that similar sentiments (i.e. valuing treatment with compassion, respect, and dignity over efficiency or technical skills in the healthcare setting) are not uncommon among patients.[20–22] Indeed, the positive influence of warm, patient-centric communication and of the act of physical examination on the doctor-patient relationship is a well-documented theme in medical and social sciences literature.[23] Despite claims that traditionally-taught "doctoring" and interpersonal skills are losing importance in the age of modern medicine characterised by staggering technological advance, or that the imperfect art of clinical examination is slowly become obsolete, evidence suggests that patient-centred care (which relies heavily on thoughtful utilisation of these long-established modalities) still appears to be the key to patient satisfaction.[21–24] It has even been postulated that biomedical developments may actually widen both the psychological and physical distance between doctors and patients, although further research is needed to explore this effect.[24] While computer-aided diagnostic systems are abundant and have unique, undisputable advantages,[25] they obviously cannot (yet) incorporate empathy and physical touch as powerful ways of connecting with and healing the patients with skin conditions.[5]

Conclusion

In 2018, both clinicians and patients are equipped with a variety of technological tools that may aid them in the diagnosis of skin conditions. These range from the popular self-assessment mobile applications, to the more formal use of personal electronic devices for the purposes of communicating with a specialist (as in teledermatology). While CNN-trained AI has recently shown some truly impressive abilities in detection of skin cancers, by no means does this represent

a replacement for all aspects of traditional physician consultations such as thorough history taking, physical examination, human touch, and empathy. After all, good medical practice is about much more than solely diagnostic accuracy. Furthermore, heavy reliance of medical practices on any technology inevitably brings with it a unique set of concerns (including legality and cybersecurity issues) that must be adequately addressed before widespread implementation is possible.

To conclude, despite significant technological advances of diagnostic techniques in recent years, I do not believe that machines will replace dermatologists in the diagnosis of skin disease (including, but not limited to malignant melanoma) any time soon. In my opinion, the emphasis should be on using the ever-evolving technology to complement and augment the conventional skill set of physicians, rather than to replace doctors altogether. Such symbiosis would ideally help us achieve enhanced rates of access to high-quality, appropriate dermatological care and improved outcomes for patients with melanoma and other skin disease in the most efficient and economical way possible.

References

1. Whiteman DC, Green AC, Olsen CM. Growing burden of invasive melanoma: projections of incidence rates and numbers of new cases in six susceptible populations through 2031. J Invest Dermatol. 2016;136:1161–71.

2. Anwar SM, Majid M, Qayyum A, Awais M, Alnowami M, Khan MK. Medical image analysis using convolutional neural networks: a review. J Med Syst.2018 Nov 1;42(11):226.

3. Rawat W, Wang Z. Deep convolutional neural networks for image classification: a comprehensive review. Neural Comput. 2017 Sep;29(9):2352–449.

4. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017 Feb;542(7639):115.

5. Haenssle HA, Fink C, Schneiderbauer R, Toberer F, Buhl T, Blum A, et al. Man against machine: diagnostic performance of a deep learning convolutional neural network for dermoscopic melanoma recognition in comparison to 58 dermatologists. Ann Oncol. 2018 May 28;29(8):1836–42.

6. Mar VJ, Soyer HP. Artificial intelligence for melanoma diagnosis: how can we deliver on the promise? Ann Oncol. 2018 Aug;29(8):1625–1628.

7. Anyanwu CO, Lipoff JB. Smartphones, photography, and security in dermatology. J Am Acad Dermatol. 2015 Jan 1;72(1):193–5.

8. Börve A, Terstappen K, Sandberg C, Paoli J. Mobile teledermoscopy—there's an app for that! Dermatol Pract Concept. 2013 Apr;3(2):41.

9. Bashshur RL, Shannon GW, Tejasvi T, Kvedar JC, Gates M. The empirical foundations of teledermatology: a review of the research evidence. Telemed J E Health. 2015 Dec 1;21(12):953–79.

10. Tensen E, Van Der Heijden JP, Jaspers MW, Witkamp L. Two decades of teledermatology: current status and integration in national healthcare systems. Curr Dermatol Rep. 2016 Jun 1;5(2):96–104.

11. Cox NH. Palpation of the skin—an important issue. J Roy Soc Med. 2006 Dec;99(12):598–600.

12. Brewer AC, Endly DC, Henley J, Amir M, Sampson BP, Moreau JF, et al. Mobile applications in dermatology. JAMA Dermatol. 2013 Nov 1;149(11):1300–4.

13. Wolf JA, Moreau JF, Patton TJ, Winger DG, Ferris LK. Prevalence and impact of health-related internet and smartphone use among dermatology patients. Cutis. 2015 Jun;95(6):323–8.

14. Wang JV. Chapman LW, Keller, MS. Challenges to smartphone applications for melanoma detection. Dermatol Online J. 2017 Feb 15;23(2).

15. Wolf JA, Moreau JF, Akilov O, Patton T, English JC, Ho J, et al. Diagnostic inaccuracy of smartphone applications for melanoma detection. JAMA Dermatol. 2013 Apr 1;149(4):422–6.

16. Kassianos AP, Emery JD, Murchie P, Walter FM. Smartphone applications for melanoma detection by community, patient and generalist clinician users: a review. Br J Dermatol. 2015 Jun;172(6):1507–18.

17. Chao E, Meenan CK, Ferris LK. Smartphone-based applications for skin monitoring and melanoma detection. Dermatol Clin. 2017 Oct 1;35(4):551–7.

18. Rat C, Hild S, Sérandour JR, Gaultier A, Quereux G, Dreno B, et al. Use of smartphones for early detection of melanoma: systematic review. J Med Internet Res. 2018 Apr;20(4).

19. Kownacki S. Skin diseases in primary care: what should GPs be doing? Br J Gen Pract. 2014 Aug;64(625):380–1.

20. Joffe S, Manocchia M, Weeks JC, Cleary PD. What do patients value in their hospital care? An empirical perspective on autonomy centred bioethics. J Med Ethics. 2003 Apr 1;29(2):103–8.

21. Epstein, RM, Street RL. The values and value of patient-centered care. Ann Fam Med. 2011;9(2):100–3.

22. Miles A, Mezzich J. The care of the patient and the soul of the clinic: person-centered medicine as an emergent model of modern clinical practice. Int J Pers Cent Med. 2011 Jun 30;1(2):207–22.

23. Kugler J, Verghese A. The physical exam and other forms of fiction. J Gen Intern Med. 2010 Aug 1;25(8):756–7.

24. Iida J, Nishigori H. Physical examination and the physician-patient relationship: a literature review. MedEdPublish. 2016 Oct 12;5.

25. Masood A, Al-Jumaily AA. Computer aided diagnostic support system for skin cancer: a review of techniques and algorithms. Int J Biomed Imaging [Internet]. 2013 [cited 2018 Oct 28]. Available from: https://www.hindawi.com/journals/ijbi/2013/323268/abs/.

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