Artificial intelligence for melanoma diagnosis: How can we deliver on the promise?

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Currently, diagnostic accuracy for melanoma is dependent on the experience and training of the treating doctor. In this issue of the Annals of Oncology , Haenssle et al.[1] have shown that a computer algorithm using convolutional neural networks outperformed the majority of 58 dermatologists tested in accurately diagnosing melanoma, with a median area under the receiver operating characteristic curve of 0.86 compared to 0.79, $p<0.01$. This, together with the recent landmark work by Esteva et al. [2] shows that artificial intelligence (AI) promises a more standardised level of diagnostic accuracy, such that all people, regardless of where they live or which doctor they see, will be able to access reliable diagnostic assessment. The downstream effects of improved diagnostic accuracy are tangible: earlier diagnosis, more appropriate referrals to specialists, fewer unnecessary procedures and therefore less morbidity and better outcomes for patients at lower cost to the healthcare system. So can we deliver on this promise in the real world setting and what are the potential barriers?

It is important to consider how this technology might be used and in what setting. First, consider the function of AI as a screening or triage tool to ensure timely access for people requiring more urgent attention. There is a lack of evidence that population-based screening programs for melanoma are effective, and they may be harmful due to high false positive rates and overdiagnosis [3]. Targeted surveillance of patients at high risk, however, has been shown to be effective at detecting melanomas early with lower associated cost [4-6]. For high-risk patients requiring total body photography and sequential dermoscopic imaging, changing lesions could be flagged automatically by AI systems integrated into cutting edge 2D or 3D imaging technology [7] (Figure 1). Automated filtering of benign lesions would allow more efficient management of suspicious lesions and improve access to specialists. Unfortunately, people in rural areas have limited access to diagnostic services which can adversely affect disease outcomes [8]. High resolution total body imaging with integrated AI capability would therefore transform health care provision in these areas.

Given the high prevalence of melanoma, there is a growing number of people who require life-long surveillance. This places enormous burden on specialist services, which could potentially be alleviated by improved patient-led surveillance systems. It has been shown that people with melanoma and their partners reliably perform self-skin examination (SSE) following a training intervention, detecting more new melanomas than untrained couples

[9]. Without the assistance of a partner, it can be difficult for people to detect lesions in hard-to-see locations. It is also difficult for people with multiple dysplastic naevi to correctly select the most concerning lesions to image [10]. Whilst it may be feasible to monitor some people with teledermoscopy [11], others may be resistant to fewer scheduled visits [12] . The addition of AI to smartphone applications, which could not only remind and coach people to perform SSE, but could also flag suspicious lesions and relay this information to the treating physician, may be more acceptable than traditional store and forward teledermatology. The automated smartphone applications currently available do not incorporate AI technology and are unreliable due to their poor diagnostic sensitivity [13] Unfortunately, regulatory authorities struggle to keep up with the ever-increasing number of mobile medical devices available [14, 15]. Physicians, therefore, need to be aware of advances in technology in order to counsel their patients appropriately on the use of such technology.

Another application for AI technology is as a decision support tool. We foresee AI being integrated into a routine consultation, with clinical examination, photography of suspicious lesions and AI support to assist the clinician reach an appropriate management decision. A major objective of the dermatology consultation is to correctly diagnose lesions that the patient is concerned about. In one study, patients presenting with superficial spreading melanoma had the lesion correctly diagnosed and biopsied on the first visit 70% of the time, whereas only 43% of patients presenting with nodular melanoma (NM) had the lesion biopsied on the first visit [16]. Patients with NM often sought attention several times before the correct diagnosis was made and were more likely to be reassured that the lesion was benign [16]. Whilst human diagnosis is subjective and may be influenced by external factors, machine diagnosis is not.

It is unknown, however, how well AI will perform in diagnosing atypical melanomas. This has not been adequately addressed by studies to date, and algorithms would need rigorous testing in the clinical setting before this technology is implemented into routine care. Atypical melanomas often lack pigment and may have dotted and linear irregular vessels which are diagnostic on dermoscopy [17], but can be difficult to image as they are compressed by the contact plate when photographed (Figure 2). This also impairs inclusion of adequate numbers of challenging lesions into training data sets. This is the catch; for challenging lesions where machine-assisted diagnosis would be most useful, the reliability is lowest.

Another important component of a skin cancer consultation is the detection of melanomas of which the patient is unaware. This involves a full skin examination, including the scalp and acral surfaces; areas that are inherently difficult to photograph. Whilst dermatology is a visual speciality, it is also a tactile one. Subtle melanomas may become more apparent with touch as they feel firm or look shiny when stretched [18]. The melanoma presented in figure 2 was detected primarily by palpation as a small firm nodule in a patient with multiple lentigines and widespread solar damage. In the near future even the physician’s touch may be automated [19]. The integration of AI with robotics means that AI will not be limited to image analysis but may encompass other areas of a doctor–patient visit.

There is some concern that the use of AI will lead to de-skilling of the workforce [20]; however, much of the skill comes with knowing what to image, how to interpret the results and what the most appropriate next step is. Provided the most concerning lesions are selected for imaging, images capture the diagnostic features within a lesion (eg. vascular pattern), and the diagnostic algorithm can interpret them correctly, AI will no doubt be an excellent support tool. Currently, there is no substitute for a thorough clinical examination. However, 2D and 3D total body photography is able to capture about 90 to 95% of the skin surface and given exponential development of imaging technology we envisage that sooner than later, automated diagnosis will change the diagnostic paradigm in dermatology. Still, there is much more work to be done to implement this exciting technology safely into routine clinical care.

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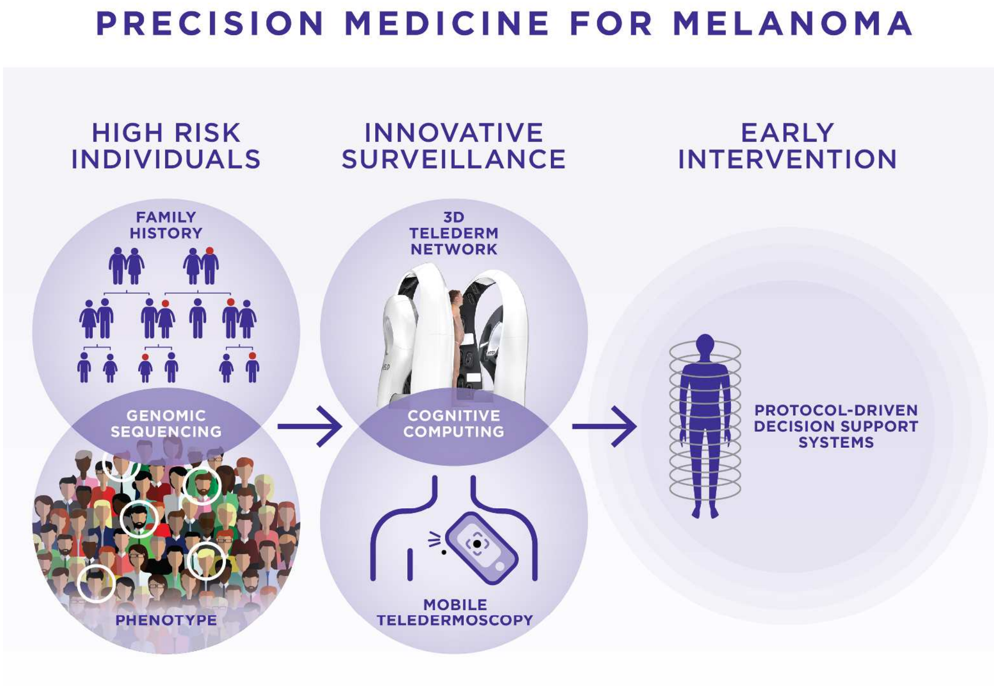
Figure legends:

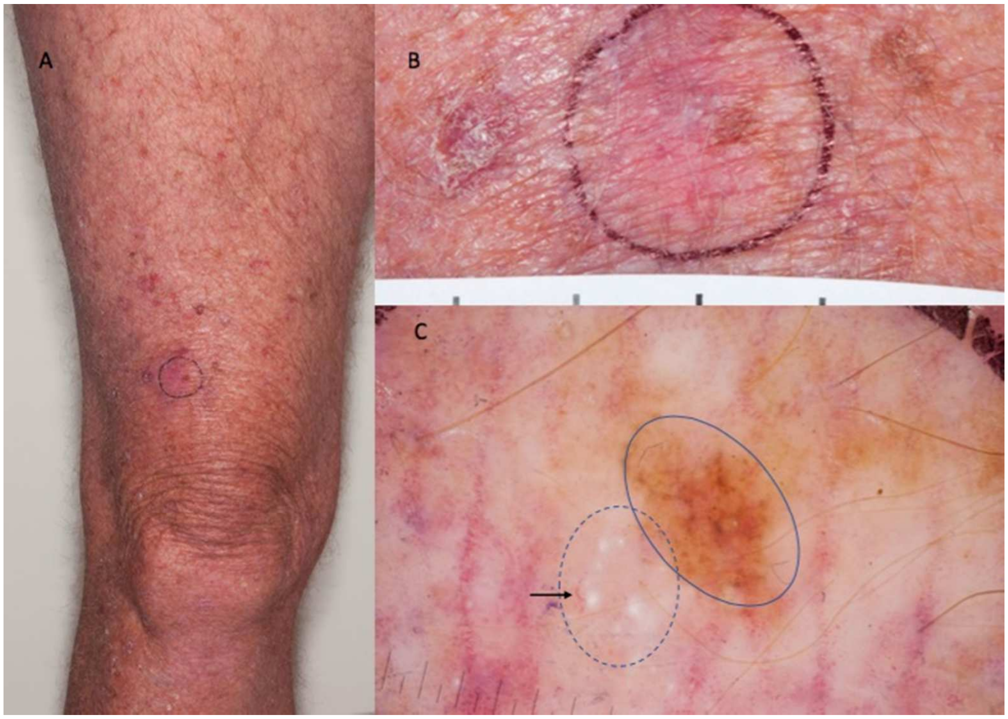
Figure 1:
The future of melanoma early detection with targeted surveillance of high risk individuals using high resolution 3D imaging technologies with integration of artificial intelligence systems (schematic from Smithers BM, Dunn J and Soyer HP. Whither melanoma in Australia? Med J Aust 2017; 207 (8): 330-331. © Copyright 2017 The Medical Journal of Australia – reproduced with permission.)

Figure 2:
A and B. Macroscopic image of a 1.3mm superficial spreading melanoma arising in sun-damaged skin of the right anterior thigh. C. Polarised Dermoscopy (magnification x10) showing asymmetrical pigment network (solid line) relatively inconspicuous amongst other lentigines, but clinically concerning firm, palpable featureless area (dotted line) with atypical vessels (arrow) which were diagnostic on dermoscopy, but difficult to image.



The future of melanoma early detection with targeted surveillance of high risk individuals using high resolution 3D imaging technologies with integration of artificial intelligence systems (schematic from Smithers BM, Dunn J and Soyer HP. Whither melanoma in Australia? Med J Aust 2017; 207 (8): 330-331. © Copyright 2017 The Medical Journal of Australia – reproduced with permission.)

254x190mm (300 x 300 DPI)



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192x137mm (96 x 96 DPI)