falsification, and so can be counterproductive to our collective goal of improving maternal health worldwide.

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Computer-assisted diagnosis for skin cancer: have we been outsmarted?

Skin cancer is the most common malignancy in fair-skinned populations, with melanoma incidence the highest in New Zealand and Australia (50 and 48 per 100 000 population, respectively) and projected to increase in the UK (from 17 to 36 per 100 000 population) and in the USA (from 29 to 32 per 100 000 population) between 2007–11 and 2022–26.[1] Non-melanoma skin cancer is up to 20 times more common than melanoma worldwide.[2] For every melanoma diagnosed, there are from three to 40 benign lesions biopsied; the proportion of biopsied lesions that are benign is generally greater in primary care than in specialist settings.[3] The annual cost of skin cancer treatment has been estimated at US$8·1 billion in the USA[4] and continues to rise. To improve diagnostic accuracy, reduce health-care costs from unnecessary procedures, and improve outcomes for patients, there has been enormous interest and investment in the development of computer-assisted diagnosis of skin cancer, particularly for melanoma.

Skin cancer clinical assessment has improved considerably over recent decades, particularly with the use of dermoscopy.[5] However, pattern recognition is operator dependent. Therefore, automated pattern recognition systems have been developed to assist in clinical decision making.[6] Although some automated systems may improve sensitivity, the trade-offs have been poor specificity and high cost, which therefore limit their use for screening.[6] However, Esteva and colleagues[7] recently reported on new technology using deep convolutional neural networks (CNN). This computational model was trained on a large dataset of 129 450 dermatologist-labelled (including 1942 biopsy-labelled) clinical images, and was found to have similar diagnostic sensitivity and specificity to dermatologists.[7]

These findings are of considerable interest because of the potential of CNN to improve diagnostic accuracy of skin cancer. However, CNN-based classification of skin

cancer has not been validated in the clinical setting. Esteva and colleagues[7] tested CNN on a set of biopsy-proven lesions (135 keratinocytic, 130 melanocytic, and 111 dermoscopic images) and compared this approach with dermatologists' blinded assessment of the same images to either "reassure or treat/biopsy". In the clinical setting, diagnosis also relies on a history of the lesion, risk profile of the individual, and global assessment of their skin, which can also identify skin cancers the patient is unaware of. In addition to "reassure or treat/biopsy", monitoring is also a frequently used management strategy,[5] particularly for flat naevi. While most benign naevi are stable over time, melanomas change in size, colour, and shape. Full skin photography combined with short-term dermoscopic monitoring is useful for the detection of subtle structural changes within naevi that otherwise lack diagnostic features of melanoma. This approach can provide reassurance that a lesion is benign, thereby avoiding unnecessary excisions and reducing health-care costs.[8]

Esteva and colleagues[7] also suggest that the use of CNN technology in smartphone applications could improve access to timely skin cancer diagnosis at low cost to the patient. Smartphone applications exist that provide information on risk of skin cancer, advice about ultraviolet protection, self-skin examination instructions and reminders, as well as image storage, monitoring, and classification.[9] Until 2014, these applications were unregulated,[10] which raised safety concerns. One study that compared the diagnostic accuracy of four smartphone applications showed significant variability in specificity, with three applications misclassifying more than 30% of melanomas as benign.[11] Another study compared three smartphone applications, revealing poorer sensitivity (21–72%) and variable specificity (27–100%) than with dermatologist assessment.[12] Mobile applications that analyse a skin lesion and provide the user with a risk assessment of that lesion are classified as mobile medical applications and are now the focus of the US Food and Drug Administration's regulatory oversight.[10] But the safety of patient-led diagnosis and implications for appropriate referral and management are not yet known. Validation of these applications in the clinical setting is a crucial step in ensuring patient safety.

Arguably, improving diagnostic accuracy of subtle in-situ lesions could increase melanoma detection without a corresponding reduction in melanoma mortality. Aggressive tumours often grow rapidly and there is a narrow window of opportunity for early detection. Since many of these tumours present with atypical clinical features (they may be non-pigmented and lack the usual ABCD diagnostic criteria),[13] opportunities for early diagnosis are often missed.[14] If a computer-based algorithm can correctly classify amelanotic and less typical presentations of melanoma, including nodular, acral lentiginous, and desmoplastic subtypes, it would likely be effective in improving outcomes for these patients. Although amelanotic melanomas were included as a training class in the recent study by Esteva and colleagues,[6] it is unclear how their system would perform in accurately classifying these subtypes.

Amelie-Benoist/BSIP/Science Photo Library

Since melanomas with atypical features can mimic more benign lesions, histological examination of an adequate biopsy (preferably excisional) is important.[15] Although histological examination is the gold standard for diagnosis of skin tumours,[16] it is important to recognise that concordance among pathologists varies, particularly when distinguishing dysplastic naevi from early in-situ melanomas and classifying atypical Spitzoid, naevoid, and acral tumours.[17] Images of such cases provided in training classes for CNN therefore require robust histological classification and it is difficult to predict how a machine would be able to generalise in these situations.

Despite advances in therapeutic options for patients with advanced stage disease, early detection of primary melanoma remains the most effective strategy to reduce

mortality. The CNN technology is exciting in its promise of highly accurate image classification, particularly if it assists in the diagnosis of clinically atypical lesions and we await the findings of further research in this area. However, smartphone applications intended for patient-led surveillance and non-expert use must undergo robust prospective validation in a blinded clinical trial and be subject to ongoing safety and efficacy reporting to regulatory authorities to ensure they first do no harm.

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Arab youth respond to the *Lancet* Commission on adolescent health and wellbeing

For **the *Lancet* Commission on adolescent health and wellbeing** see http://www.thelancet.com/commissions/adolescent-health-and-wellbeing

The *Lancet* Commission on adolescent health and wellbeing[1] is a rich compendium of evidence on adolescent health globally, and highlights the importance of youth engagement. Such engagement is vital in the Arab region where youth (15–29 years) comprise about 30% of the population.[2] Young people in this region are exposed to structural violence and conflict that affect every aspect of their lives[2]—a situation that exacerbates the uncertainties of an already tumultuous life stage. Yet young people in the region have used their voices constructively to push for equity and justice.[3] Among these voices is that of the Arab Youth Health Coalition (AYHC) that took part in the regional launch of the *Lancet* Commission's report at the American University of Beirut (AUB), Lebanon.[4]

Overall, members of the AYHC welcome the evidence set out by the Commission on adolescent health as an opportunity to prioritise topics for research, intervention, and policy in the Arab region. The concepts of the triple dividend and of the importance of secondary education as an investment in adolescent health resonates with AYHC members. But the scarcity of evidence in the Commission from the Middle East is a cause for concern. The AYHC attributes this to the absence of robust