

Early detection of skin cancer in Australia – current approaches and new opportunities

Monika Janda^a, Catherine M Olsen^{b,c}, Victoria J Mar^{d,e,f} and Anne E Cust^{g,h,i}

^a Centre for Health Services Research, Faculty of Medicine, University of Queensland, Brisbane, Australia

^b Cancer Control Group, QIMR Berghofer Medical Research Institute, Brisbane, QLD, Australia

^c Faculty of Medicine, University of Queensland, Brisbane, Australia

^d Victorian Melanoma Service, Alfred Health, Melbourne, Australia

^e School of Public Health and Preventive Medicine, Monash University, Melbourne, VIC, Australia

^f Skin and Cancer Foundation Inc., Melbourne, VIC, Australia

^g Daffodil Centre, University of Sydney, a joint venture with Cancer Council NSW, Sydney, Australia

^h Melanoma Institute Australia, University of Sydney, NSW

ⁱ Corresponding author: anne.cust@sydney.edu.au

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Key points

- The large health and financial impacts of skin cancer can be minimised through early detection
- Concerns about the current unstructured approach to skin cancer early detection include variable quality of care, sociodemographic inequalities, excision of many benign lesions, overdiagnosis, gaps in workforce training, and health system inefficiencies
- Australia is experiencing a changing landscape of skin cancer early detection, driven by increasing health system costs, advances in diagnostic technologies and artificial intelligence, validated risk-stratification tools, and consumer-driven digital technologies

Abstract

Objectives and importance of study: Melanoma and keratinocyte carcinomas impose a significant health and financial burden on the Australian population and healthcare system. The impacts of skin cancer can be minimised through early detection, as morbidity, mortality and costs of treatment are strongly associated with stage of disease at diagnosis.

Study type: Narrative review.

Methods: Building on the discussions from the Melanoma Screening Summit held in Brisbane, Australia, in 2019, we reviewed evidence related to current approaches and new opportunities for early detection of melanoma and other skin cancers.

Results: Population-based melanoma screening is not currently recommended due to insufficient evidence that screening reduces melanoma mortality. Instead, in most countries including Australia, early detection of melanoma and keratinocyte carcinomas is undertaken opportunistically, by either the patient presenting for a routine skin check or with a lesion of concern, or by the doctor detecting a lesion incidentally. Several concerns about the current unstructured approach to skin cancer early detection have been identified, including variable quality of care, sociodemographic inequalities in medical access and health outcomes, excision of many benign lesions, overdiagnosis, gaps in workforce training, and health system inefficiencies. There has also been renewed interest in melanoma screening in Australia, driven by a changing landscape of skin cancer early detection. These changes include increasing health system costs for adjuvant therapies, advances in diagnostic technologies and artificial intelligence, the availability of validated risk-stratification tools, and consumer-driven digital technologies.

Conclusions: The future of skin cancer early detection in Australia and internationally may incorporate features such as a more structured approach to skin cancer risk assessment using online risk calculators and invitations to screen, consumer-driven melanoma surveillance, and new technologies for diagnosis and monitoring of lesions. High-quality research evidence is being generated across multiple research programs, and is essential to underpin any changes to policy and practice in skin cancer early detection.

Introduction

Melanoma and non-melanoma skin cancers (mostly keratinocyte carcinomas including basal cell carcinomas [BCCs] and squamous cell carcinomas [SCCs]) impose a significant health and financial burden on the Australian population and healthcare system.¹⁻³ Australia has the highest skin cancer rates in the world⁴ and they represent the most expensive cancer for our health system.¹ The incidence of melanoma continues to increase in many parts of the world.⁵ In Australia, incidence and mortality trends vary considerably by age, with reductions observed over time in melanoma incidence and mortality by the age of 30 years, largely attributable to Australia's skin cancer prevention campaigns⁶, stable incidence rates to age 60, and increased incidence particularly over the age of 80.^{5,7} People who develop a melanoma also remain at elevated risk of developing a subsequent primary melanoma.⁸

There were an estimated 2439 deaths from skin cancer in 2019, the majority (1725; 71%) from melanoma and the remainder (714 deaths) from non-melanoma skin cancer.⁹ If melanoma is detected at an early stage when the tumour is thin, the person has an excellent prognosis, with 95% 10-year survival for stage I disease.¹⁰ Despite this, because most melanomas are diagnosed at an early stage, thin melanomas still represent a sizable proportion of all melanoma deaths.¹¹ When melanoma is diagnosed at a later stage, prognosis is poorer and health system costs are much higher, particularly due to treatment with immunotherapies.² Advanced keratinocyte skin cancers, especially those occurring on exposed areas of the skin such as the scalp, pose major treatment problems and may require combinations of sequential surgery, radiotherapy and chemotherapy.

Population-based melanoma screening is not currently recommended due to insufficient evidence that screening reduces melanoma mortality.¹² Instead, in most countries including Australia, early detection of melanoma and keratinocyte carcinomas is undertaken opportunistically, by either the patient presenting for a routine skin check or with a lesion of concern, or by the doctor detecting a lesion incidentally.¹³ In 2016–17 in Australia, a whole-body skin check was reported by 37% of those aged 45–69 years, 20% of those aged 25–44 years, and 9% of those aged 18–24 years. Among those aged 45–69 years, 8% reported a part-body skin check, 14% reported

a check of a mole or spot, and 41% reported no skin check.¹⁴ The relatively high prevalence of skin checks in Australia is probably due to multiple factors including high awareness of skin cancer⁶, the presence of designated primary care skin cancer clinics, and community-wide prevention campaigns.

In 2019, a Melanoma Screening Summit was held in Brisbane, Australia, to review evidence regarding current approaches for early detection of melanomas and explore new opportunities.¹⁵ Several concerns about the current unstructured approach were identified, including variable quality of care (with lack of quality assurance or reminder systems), sociodemographic inequalities in access to skin checks, clinical care and in melanoma outcomes, excision of many benign lesions, overdiagnosis, gaps in workforce training, and health system inefficiencies.¹⁵ There was also acknowledgement of a renewed interest in melanoma screening, driven by the increasing health system costs for adjuvant therapies, advances in diagnostic technologies and artificial intelligence, the availability of validated risk stratification tools, and consumer-driven digital technologies.¹⁵ We discuss some of these concerns and opportunities for skin cancer early detection in more detail below.

Overdiagnosis

In a recent paper, Welch et al.¹⁶ presented a discussion of melanoma incidence trends in the US and the likely respective contribution of changes in prevalence of ultraviolet radiation exposure and the overdiagnosis of indolent lesions, i.e. those that are unlikely to metastasise and cause death if they were not detected during routine skin examinations. Welch et al. concluded that increased diagnostic scrutiny (defined as the combined effect of an increase in skin examinations, lower clinical thresholds to biopsy pigmented lesions and lower pathological thresholds to diagnose lesions) explained most of the rising incidence of melanoma in the US. The authors noted the disparity between rising incidence and stable melanoma mortality as further evidence of overdiagnosis. Melanoma mortality in the more susceptible US population (non-Hispanic whites) increased significantly up until 2013, when the introduction of new systemic therapies began to have an impact on survival.¹⁷

Furthermore, a trend of increasing melanoma incidence in US adults aged 40 years or older is apparent for not only local (early-stage) disease, but also regional and distant diagnoses.¹⁸ Thus it is unlikely that the increase in melanoma incidence can solely be attributed to overdiagnosis.

In Australia¹⁹ and other parts of the world including Europe²⁰, there has been an increase in the incidence of in situ and thin melanomas relative to thick melanomas. These trends likely reflect, at least in part, higher levels of surveillance as a result of increased awareness of the importance of early detection in reducing morbidity and mortality. Direct evidence for the overdiagnosis of cancers, including breast and prostate cancer, is derived from screening trials by comparing incidence in screened and non-screened groups. Since population-based screening is not recommended for melanoma¹², there are no comparable screening trials for melanoma and thus the degree of overdiagnosis in the population is difficult to quantify. Australian researchers are currently using different methods to attempt to understand the extent of overdiagnosis of different cancer types.²¹ An analysis of differences in lifetime risk between 1982 and 2012, interpreted as probable overdiagnosis, estimated the proportion of all melanomas (including in situ melanomas) overdiagnosed at 58% of all melanomas among men and 54% among women.²² This was driven mainly by diagnosis of in situ melanomas, as the estimated proportion overdiagnosed for invasive melanomas was only 22% among men and 15% among women.²²

The diagnosis of indolent lesions can cause harms including morbidity from unnecessary treatment, psychological distress and financial burden for patients and the health system. Thus ideally, the emphasis of screening should be on finding melanomas that are clinically significant. Although this is an area of active research, there is currently no reliable way of distinguishing between an indolent lesion and one that is likely to progress.

Skin cancer risk assessment

The past 5 years has seen considerable growth in the development and application of skin cancer risk-assessment tools. Australian clinical practice guidelines now recommend that all patients are assessed for future risk of melanoma using a validated risk-prediction tool, and that people at very high risk of melanoma have a 6-monthly full skin examination supported by total body photography and dermoscopy.²³ Limitations of earlier risk-assessment tools, such as lack of external validation and prospective evaluation²⁴, have been addressed in more recent studies^{25,26} or are being currently evaluated prospectively. These risk prediction tools have a good ability to discriminate whether or not a person will develop a melanoma and thus are suitable for stratifying levels of risk, although may not be well calibrated when estimating

absolute risk, and there is no consensus on the optimal thresholds to classify risk.²⁶ Several risk assessment tools for melanoma and keratinocyte carcinomas have been developed using Australian data^{8,25-28} and some are available online. Of relevance to a potential melanoma screening program, studies of the cost effectiveness of routine screening or surveillance suggest that targeting high-risk groups is more cost-effective than an untargeted approach.^{29,30} Further, the US Preventive Services Task Force recommended, after a comprehensive review of the evidence in 2016, that “future research on skin cancer screening should focus on evaluating the effectiveness of targeted screening in those considered to be at higher risk for skin cancer”.³¹

Consumer-driven melanoma surveillance

Consumer-driven digital technologies are becoming increasingly popular and embedded into everyday life, with a wide variety of home-use devices and smartphone apps to choose from. Web-based and smartphone apps can provide prevention and early detection advice, prompt and record results from skin self-examinations (SSE) and facilitate mobile teledermatology whereby digital images are taken by the consumer and sent to either an automatic algorithm or a clinician, commonly a dermatologist, for remote evaluation. A review of skin cancer apps available in 2019 found there were 66 apps commercially downloadable for consumers, often offering multiple functionalities, with just under half (49%) aimed at supporting monitoring and tracking of lesions, followed by artificial intelligence image lesion analysis (39%), education provision (38%) and teledermatology services (27%).³² These technologies are becoming even more relevant due to a higher use of telehealth during the ongoing COVID-19 pandemic.³³

The diagnostic accuracy of patient-performed mobile teledermoscopy for melanoma surveillance has been demonstrated in observational and pilot studies, along with its feasibility and acceptability.^{34,35} Janda and colleagues recently conducted a large randomised controlled trial comparing patients using SSE with or without conducting mobile teledermoscopy at home to detect their own lesions suspicious for skin cancer.³⁶ Both groups had a high degree of sensitivity (>75%) and specificity (>87%) in detecting suspicious lesions that the dermatologist also thought were worthwhile checking, and no melanoma was overlooked by the patients in the mobile teledermoscopy group.³⁶ Following this study, the researchers recommended naked-eye SSE should be continued by cancer agencies for early detection of skin cancers as mobile teledermoscopy did not significantly improve sensitivity for skin cancer, however the study was not large enough to make recommendations for melanoma specifically. Another large-scale randomised controlled trial is currently underway that will assess the

impact of mobile teledermoscopy in melanoma patient follow-up care and whether the technology may assist with melanoma diagnosis between routinely scheduled in-person care.³⁷ Previous research has found that patients identify up to 40% of melanoma recurrences³⁸, and this technology may further assist with a more rapid diagnosis. Moving to patient-led surveillance would require improvement of SSE education and practice, which is currently suboptimal in the general population, with studies suggesting that few people carry out SSE thoroughly.³⁹

Compared with the traditional clinician-led approach, consumer-driven and clinic-based digital technologies may increase consumers' support for SSE and self-management if it allows them to obtain fast-track access to their doctor for urgent review of a concerning lesion. Technology-facilitated SSE may reduce the need for in-person follow-up consultations, thereby reducing travel expenses and allowing more equitable service provision in rural and remote areas. The integration with artificial intelligence algorithms that highlight whether or not a skin lesion is potentially suspicious may further improve upon the existing technologies, but this is still in its early stages of development and the impact in a real-world setting needs to be evaluated.⁴⁰ Consumer-driven technologies, alongside other clinician-led technologies such as 3D total-body imaging, may inform a more systematic approach to early detection of melanoma in the future. However, this will not be without challenges, including the need to regulate standards for this model of care, in particular concerns about medicolegal liability, data privacy and security. Consumer-driven, personalised technologies will need to be further tested in clinical trials for their efficacy, utility and cost-effectiveness.

Technologies and training to support the early detection of skin cancer in Australia

There has been considerable interest in the use of diagnostic aids for skin cancer management, including imaging devices with artificial intelligence algorithms integrated.⁴⁰⁻⁴² Although there has been promising research to show the performance of convolutional neural networks, a type of artificial intelligence, on par or superior to dermatologists' assessment of the same images in experimental settings, there is a paucity of data from prospective studies in the clinical setting. It is unknown how the use of these algorithms might impact clinical practice (eg. benign: malignant excision rates) and costs to both patients and the healthcare system. There are also significant considerations regarding the transparency of algorithms (how the model was built and how they arrive at a diagnosis) and their generalisability (whether the training data is appropriate for the population and lesion types intended for use).

Therefore, while some diagnostic devices are currently commercially available, current Australian guidelines do not recommend their routine use in clinical practice.²³

Dermoscopy is the mainstay of skin cancer diagnosis and, as described by Jones et al in this issue of the journal⁴³, training needs remain high for general practitioners, who diagnose the majority of skin cancers in Australia. The new generation of clinicians will also require a degree of upskilling in the use of novel diagnostic devices. There is concern that over-reliance on artificial intelligence may lead to a de-skilling of the workforce. Clinical judgement is required to identify potential erroneous artificial intelligence outputs and avoid being misled by a 'trusted' algorithm if, for example, it is exposed to a rare lesion that it has not been exposed to in training.⁴⁰ There is a significant opportunity however, to take advantage of artificial intelligence for training and upskilling, with the design of interactive web-based case examples with diagnostic feedback.

The future of skin cancer early detection in Australia

The 2019 Melanoma Screening Summit concluded that changing from the current unstructured, opportunistic approach to skin cancer early detection to a structured population-based or targeted screening program would require further evidence, including comparing the benefits, harms and cost-effectiveness of different approaches.¹⁵ The Australian Population-Based Screening Framework⁴⁴, developed based on principles from the World Health Organization, outlines the criteria by which structured population-based screening programs are assessed, and also notes that the framework is not designed to address targeted testing of high-risk groups. It specifies the need for a strong evidence base, including evidence of the safety, reproducibility and accuracy of the screening test and the efficacy of treatment. It also emphasises that a screening program must offer more benefit than harm to the target population. Current Australian research programs are addressing these evidence gaps, and include (for more details, see Supplementary file 1, available from: doi.org/10.6084/m9.figshare.19248027):

- Modelled evaluations of risk-stratified melanoma screening
- A randomised controlled trial of melanoma surveillance photography
- Improvements in skin cancer risk-prediction tools by incorporating imaging data of dermoscopic and phenotypic features, and genomic data
- Evaluation of advanced digital diagnostic technologies and artificial intelligence, in the clinic and by consumers
- Identifying clinical, dermoscopic and molecular features of indolent and aggressive melanomas and other skin cancers

- Understanding the quality-of-life impacts of keratinocyte carcinomas and their treatment
- Quantifying overdiagnosis
- Understanding how primary prevention can be better integrated with early detection.

Knowledge generated from this high-quality research will continue to guide the changing landscape of skin cancer early detection in Australia and internationally, and is essential to underpin any changes to policy and practice in skin cancer early detection.

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Peer review and provenance

Externally peer reviewed, invited.

Competing interests

Cancer Council NSW is a member of Cancer Council Australia. Cancer Council Australia derives income from the sale of sun protection products that is used to fund cancer research, prevention and support activities. VM has received honoraria from Merck, Janssen, Novartis and Bristol Myers Squibb, and is principal investigator for a clinical trial funded by the Victorian Department of Health, with matched 1:1 funding from MoleMap, which provides skin cancer detection, diagnosis and skin-mapping services.

Author contributions

All authors contributed to the design, drafting, interpretation, reviewing and editing of the manuscript.

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