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A Narrative Review of Models Used to Screen for, Diagnose and Manage Skin Cancers in Rural and Remote Areas

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Abstract

Introduction: Skin cancer is a major public health issue in Australia, especially for those in rural areas. To overcome the unique challenges that exist in providing care to rural and other isolated populations, novel and innovative approaches are required for earlier detection, prompt management and improved health outcomes.

Objective: To review models of skin cancer screening, diagnosis and management employed in rural settings.

Design: Systematic search of several electronic databases (CINAHL, Cochrane, Embase, InfoRMIT, LILACS, Medline, ProQuest, PubMed) for studies that involved screening, diagnosing, or managing primary skin cancers (melanomas, squamous cell carcinomas, basal cell carcinomas) or close differentials (actinic keratoses) in rural settings internationally.

Findings: 28 studies were found, representing 5 key models of skin cancer screening, diagnosis, and management. The most used method was teledermatology which was well-received as a triage and diagnostic tool.

Discussion: In rural settings, unique initiatives are being used to screen for, diagnose and manage skin cancers in addition to or instead of routine care. Use of teledermatology was common, although rarely studied in the context of skin cancer alone. General medical practitioners provide comprehensive care from screening to management stages. Upskilling or temporarily relocating health professionals including nurses appears useful. Community education remains paramount. Further Australian-based research is required to assess the utility and feasibility of these, and other, novel models locally.

Conclusion: Teledermatology appears to be a clinical model commonly used to overcome barriers to delivering skin cancer care to rural areas. While it remains a tool with great diagnostic potential, it addresses part of the patient journey, with limited capacity during the treatment stages. Exploration of more holistic and sustainable models are likely required to address the skin cancer burden in rural areas.

KeyWords: skin cancer; melanoma; screening; diagnosis; management; rural; remote; geographically isolated; innovative model; teledermatology

List of Abbreviations

BCC = basal cell carcinoma; GP = general practitioner; RACGP = Royal Australian College of General Practitioners; SCC = squamous cell carcinoma; UV = ultraviolet

Introduction

Two-thirds of Australians are diagnosed with skin cancer by the age of 70, and the mortality, social and financial burdens continue to be significant [1]. For the one-third of Australians living in regional, rural, and remote areas [1], high ultraviolet (UV) light exposure, sub-optimal sun-protection practices, and a cultural tendency to avoid seeking health advice [2] contribute to a higher skin cancer disease burden compared with Australians living in urban areas [1].

Poorer health outcomes for rural patients [1] are amplified by long-standing barriers to accessing medical care, including distance to health services, extended waiting times and rural medical workforce shortages [2]. Despite skin cancers being more common in rural settings [1], 92% of Australian dermatologists live and work in capital cities and urban centres along the coast [3].

Currently, Australian guidelines advise against population-wide screening for skin cancer, citing a lack of evidence for both feasibility and effectiveness in reducing mortality [4]. Rather, patient self-examination and opportunistic screening in primary care, typically general practice clinics in Australia, is recommended for most patients, with 6-12 monthly whole-body skin checks advised only for those regarded as high risk (eg. past history of melanoma, fairer skin type) [5]. Whole body skin checks are typically performed by a general practitioner (GP), ideally with a dermatoscope to accurately visualise potential skin cancer lesions [6]. However, only around one half of GPs in training report having received adequate instruction [6] required for this equipment to be used effectively [7].

While a primary care approach is commonly used for diagnosing and managing most skin cancers Australia-wide, an integrated, multi-disciplinary approach involving nurses and other non-GP medical specialists is ideal for managing skin cancers, particularly for more advanced or complicated lesions [1]. In rural areas, however, management of skin cancers - including excisions and prescription of topical skin cancer medications – tends to be performed by GPs, who may be professionally isolated. This approach is advantageous insofar as patients benefit from longitudinal follow-up and holistic GP-provided care, though for skin cancers, prompt assessment remains paramount to ensure early detection and appropriate treatment. For example, the incidence and mortality of melanomas is higher in rural and remote areas compared to metropolitan regions [8] and survival rates of these lesions vary between 25% and 99% depending on the depth and degree to which the cancer has spread [1].

These rural-specific challenges have not gone unnoticed. Three of the twelve final recommendations from the report following the 2015 The Standing Committee on Health Inquiry into Skin Cancer (Australia) specifically acknowledged addressing needs in rural areas, including the vital role of nurses and primary healthcare workers. Conclusions have included the need for upskilling health professionals (including dermatoscopy training), as well as novel interventions, including the use of technological approaches such as teledermatology [1].

Aims and objectives

This study aimed to review models of service delivery for skin cancer screening, diagnosis and management employed in rural settings internationally. Models involving standard primary care service (wherein a patient presents to a primary care physician for as-

sessment of a lesion or opportunistic skin check, and lesion are locally managed or referred to a specialist dermatologist/oncologist) were excluded from this review.

Methods

Search Methods

Database searches of CINAHL, Cochrane, Embase, InfoRMIT, LILACS, Medline, Proquest and Pubmed were undertaken to the 12th of November 2022. Initially the search strategies restricted studies to within Australia, however, insufficient papers were identified. Expanding the search strategy to countries with similar healthcare systems (the United Kingdom and Canada) also yielded limited studies. Therefore, all studies found internationally were included.

Searches were performed using the keywords: ("skin cancer" OR "skin neoplasm" OR "skin malignancy" OR "melanoma" OR "squamous cell carcinoma" OR "basal cell carcinoma") AND ("screening" OR "triage" OR "surveillance" OR "early detection" OR "check*" OR "telederm*" or "locum" OR "mobile workforce" OR "artificial intelligence" OR "model* of care" OR "partner skin check") AND ("rural*" OR "remote*" OR "regional" OR "isolated" OR "small town*" OR "underserved" OR "resource limited" OR "bush" OR "outback" OR "agricultural"). Reference lists of included papers were screened for all studies considered relevant based on title and abstract. The publication lists and research profiles of lead authors were checked for other published, unpublished, or ongoing studies. Included studies were further reviewed on (Connected Papers), a website with a graphic tool designed to highlight closely related papers in a mindmap-like display.

Criteria for Including Studies for this Review

Full text articles written in English were included. Studied populations were required to be rural and/or in an area without specialist dermatologists (such as warzones and remote islands). Studies containing both metropolitan and rural patient groups were only included if the data for the two groups were disaggregated. Studies with a focus on diagnosing general dermatological conditions (for example, eczema or psoriasis) were included, providing that a primary skin malignancy (melanoma, basal cell carcinoma (BCC), squamous cell carcinoma (SCC)) or close differential diagnosis (actinic keratosis) were diagnosed in at least one patient included in the study. Kaposi's sarcoma, cutaneous T-cell lymphomas or cancers that had metastasised to the skin were not considered "skin cancers" for the purpose of this study. Secondary skin cancer prevention models were also included. Studies focusing on primary prevention (including sun protection education) or mass screening for other cancers (such as breast, colon, oral) were excluded unless measures to screen for, diagnose or manage skin cancers were able to be clearly extrapolated from the results or discussion.

Data Collection and Extraction

Included studies were collated in EndNote, and duplicates removed. One author assessed the relevance of titles, abstracts, and then full texts for eligibility. A second author confirmed the eligibility of each study. The reason for excluding all full-text articles was recorded.

Data Analysis of Included Studies

Data were extracted from included articles and collated in Excel. Data included title, authors, year of publication, start date of study, duration of study, study type, study design/overview, the application of the model in terms of treatment stage or area of potential (as one or more of screening, diagnosis, management), method/intervention (including involvement of: specialist, primary practice, self-examination/patient, community/other), number of participants (total participants, and participants specific to skin

cancers), geographical location/s, category (rural, remote, other specified category), outcomes (for example accuracy, patient satisfaction), study conclusion, other observations of note (for example patients lost to follow-up, false negatives, suggestions).

Subgroup Analysis

Analysis was performed for research papers in the following contexts:

- 1. Screening, diagnosis, management.
- 2. Involvement of allied health professionals and/or GP and/or dermatologist/surgeon/oncologist.
- 3. Studies involving skin cancer only, versus those for general dermatological conditions with or without skin cancer.
- 4. Initiation of care (did the patient self-present, or did the doctor opportunistically screen the patient)?

Results

Searches of the 8 databases retrieved 7717 articles, including 19 that met the inclusion criteria. Another 9 articles were found through reference searches and checking the Connected Papers website. In total, 28 records were included (figure 1). No ongoing studies and no studies awaiting classification were identified.

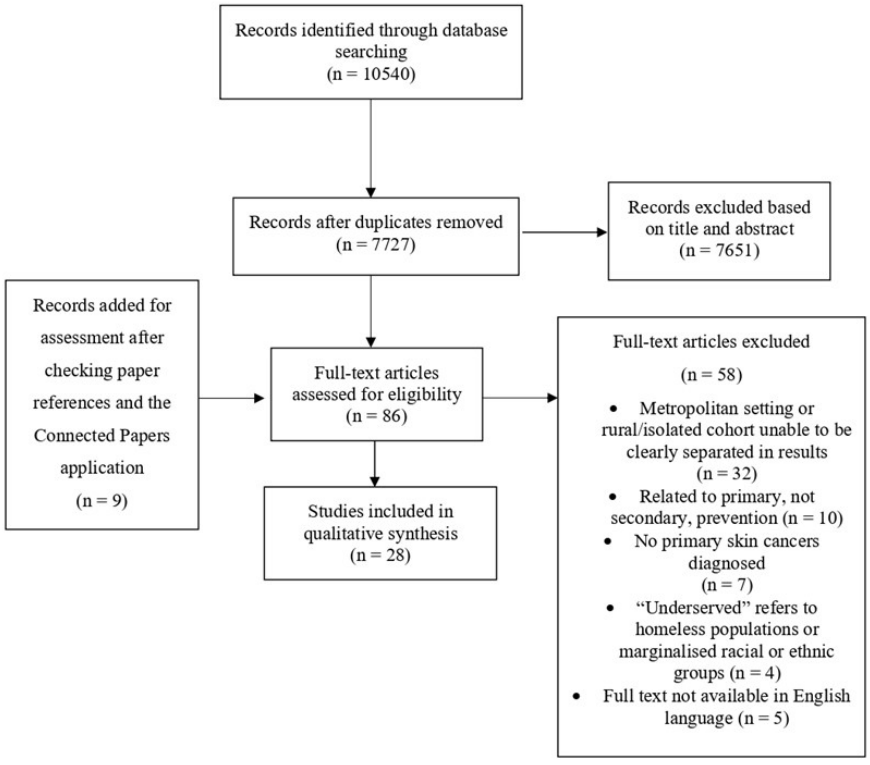

Figure 1: PRISMA diagram.

Key Findings

The 28 included studies represented data from 27 countries (figure 2). Fifteen (54%) related to investigation of skin cancer only, while the remaining 13 related to general dermatological presentations, including skin cancer (table 1).

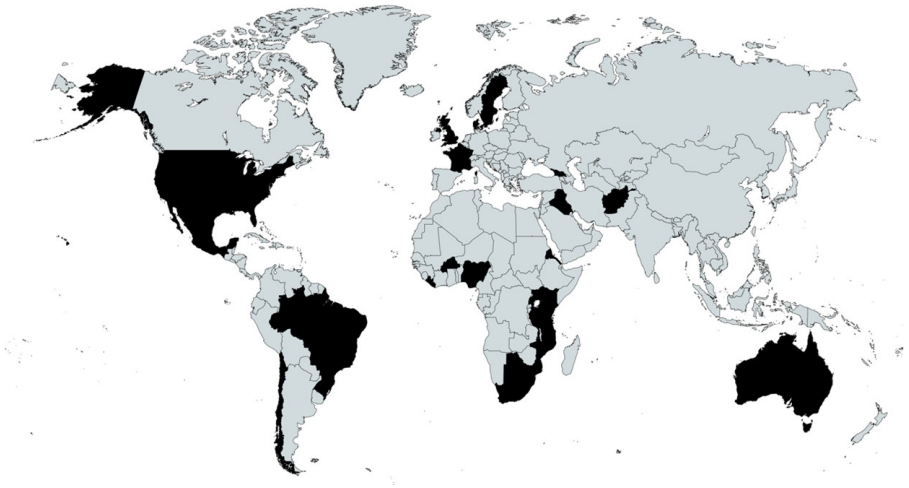

Figure 2: Country of study origin (included articles) (darkened). Made with mapchart.net

Fourteen studies (50%) were relevant to skin cancer screening [5, 9-21]. In most studies, screening was initiated by patients who self-presented for assessment [9-11, 13, 15, 17-21], however nurses (1 study) [12] or doctors (1 study) [5] were also found to initiate screening. When performed, skin examinations were typically conducted by health professionals (hospital and primary care doctors (8 studies [5, 9, 11, 14, 15, 17-20]), hospital and primary care nurses (5 studies) [10-13, 21]). In one study, patients performed self-examinations [18].

Most studies reported models relating to the diagnosis of skin cancers [5, 9-17, 19-35], some of which also included models of screening cancers ([5, 9-17, 19-21]) and treating cancers ([5, 9-11, 14, 17, 19-23, 30-34]) as well. Seventeen of the 28 papers reflected modes of managing skin cancers, including mobilising workforces already capable of managing skin cancers (for example through prescribing topical therapies or performing skin cancer excisions), upskilling health professionals to manage skin cancers, or involving inter-practitioner advice regarding how to manage a possible skin cancer [5, 9-11, 14, 17, 19-23, 27, 30-34]. In no studies was a patient managed solely by an allied health or medical student team. Patients were either managed solely by a GP (3 studies) [5, 19, 31], a GP with a dermatologist/oncologist (7 studies) [17, 20, 22, 23, 27, 33, 34], GP with nursing/allied health and dermatologist (1 study) [11], nurse with dermatologist (2 studies) [10, 21], or a dermatologist only (4 studies) [9, 14, 17, 32].

Five key methods were found across all studies:

- Teledermatology, including images captured via a camera or dermatoscope (teledermoscopy) and shared with another health professional (store-and-forward methods), or videoconferencing
- Temporary clinics (annual screenings, fly-in-fly-out setups, mobile units)
- Education of professionals (upskilling providers, GPs with diploma-level dermatology qualifications)
- Routine skin examinations by GPs
- Education of community members in identifying their own potential skin cancers (self-examination)

Paper	Country/ies	Model	Was the study specific to skin cancer?	Number of skin cancers or close differentials assessed/diagnosed using novel method in isolated context	Brief synopsis of study
Ayasse, M et al (2020) [9]	Galapagos	Temporary intervention (visiting specialists)	Yes	273	A non-profit surgical volunteer free clinic was established in the Galapagos staffed by visiting board-certified dermatologists.
Borve et al (2015) [22]	Sweden	Teledermatology	Yes	1562	Smartphone teledermoscopy referrals were sent from primary healthcare centres to an urban or rural dermatology department via a smartphone application. Images were triaged, given priority, and management was suggested.
Bryld, L (2010) [10]	Faroe Islands	Temporary intervention (visiting specialists), teledermatology	No	9161	A dermatologist visited the Tórshavn hospital dermatology clinic for 4 days every 6 weeks.
Byrom et al (2016) [11]	Australia	Teledermatology	No	36	An educational and teledermatology referral site was used to link clinicians in rural Australia, including outpatient, inpatient and nursing services, with urban dermatologists.
Caumes et al (2004) [23]	Burkina Faso	Teledermatology	No	3	Patients presented to a GP based in Ouagadougou, who forwarded images to dermatologists in France.
DeKoninck et al (2015) [12]	USA	Temporary intervention (annual screening), provider education	Yes	57	A trained family nurse practitioner held an annual skin cancer screening program.
Fruhauf et al (2013) [24]	Uganda	Teledermatology	No	8	Health workers in Uganda submitted cases via smartphones to specialists Europe, USA and Australia.
Garcia-Romero et. al (2011) [25]	Mexico	Teledermatology	No	7	Facebook was used to connect rural GPs on a remote island with dermatologists in a distant tertiary hospital.

Glenister et al (2022) [13]	Australia	Provider education	Yes	NA[2]	A nurse-practitioner with specialised training in skin cancer identification ran skin screening across four clinics in a rural Australian context, with a proposed initiative involving a group of local nurses and nurse practitioners.
Gonzalez Coloma et al (2019) [26]	Chile	Teledermatology	No	10	Retrospective analysis of 5 years of teledermatology data between 4 public health clinics and an urban hospital in Chile.
Hue et al (2016) [14]	France	Provider education, teledermatology	Yes	390	Trained medics forwarded images of suspicious lesions, along with clinical information, to four dermatologists in Paris via a website.
Hwang et al (2014) [27]	Global (USA military deployed settings, eg. Iraq and Afghanistan)	Teledermatology	No	5	Pictures obtained for dermatological presentations by on-field military medical providers were emailed to a dermatologist who replied within 24 hours with advice.
Kahn et al (2016) [28]	USA	Teledermatology	Yes	293	A retrospective chart review of California's Central Valley Kaiser Permanente conventional dermatology or teledermatology referrals with a positive skin cancer biopsy.
Kirtava, Z et al (2016) [29]	Georgia	Teledermatology	Yes	2811	A teledermatology program was established between both Tbilisi (urban) outpatient clinics and Adjara (rural seaside) outpatient clinics. In more difficult cases, a foreign "dermoscopy" network (Austrian, Australian, Italian, Polish, Turkish dermatologists) was consulted.
Kitchener et al (2020) [5]	Australia	Routine skin examination	Yes	5780	A retrospective audit of skin cancer cases identified in rural general practices found implementation of GP-based routine skin examinations for early identification and management of melanoma and SCC improve patient outcomes and facilitate local management.

Limpert, G (1995) [15]	USA	Temporary intervention (annual screening)	Yes	NA	A free skin-cancer screening clinic was held annually for 3 years in a rural general practice.
Lipoff et al (2015) [30]	Africa (12 countries)	Teledermatology	No	5	African-based clinicians forwarded photographs of dermatological presentations to a responding clinician in USA.
McFarland et al (2011) [16]	USA	Provider education, teledermatology	No	NA	An educational program for rural GPs was provided alongside teledermatology to care for veterans living in rural areas.
Murchie et al (2018) [31]	Scotland	Provider education	Yes	8598	From retrospective data, patients in Scottish rural locations were found to be twice as likely to have a melanoma excised in primary care, without significantly increased mortality from melanoma.
Norton et al (1997) [17]	USA, Marshall Islands	Teledermatology	No	7	Teledermatology was used for general dermatology in the Marshall Islands, a prison in South Florida, and for farmworkers in remote Carolina.
Phillips et al (1998) [32]	USA	Teledermatology	Yes	107	Patients were seen by a dermatologist both in person and via videoconferencing across four skin cancer screening sessions.
Robinson et al (2021) [18]	USA	Patient education (patient self-examination)	Yes	NA[3]	In the context of the COVID-19 pandemic social distancing and lockdown restrictions, almost 1000 women deemed to be at increased risk of melanoma were randomised to either a control group or group receiving education in performing skin self-examinations.

Scrace et al (2009) [19]	Australia	Temporary intervention (fly-in-fly-out)	Yes	316	The Royal Flying Doctor (RFDS) medical staff provided a one day (6-hour) face-to-face primary care clinic specifically for skin cancer screening, diagnosis, and management to communities without a doctor on a fly-in/fly-out basis every 1-2 weeks.
See et al (2005) [33]	Australia	Teledermatology	No	2	GPs forwarded photographs to a specialist dermatologist in urban New South Wales (Kogarah). The dermatologist provided a report of the diagnosis and treatment advice via email or fax, typically within 48 hours.
Silveira, C et al (2014) [20]	Brazil	Temporary intervention (mobile unit), teledermatology	Yes	460	A physician in a mobile unit in remote Brazil photographed suspicious lesions and forwarded the images to metropolitan-based oncologists.
Silveira, C et al (2019) [21]	Brazil	Temporary intervention (mobile unit), provider education	Yes	45872	Patients referred to a travelling mobile prevention unit for assessment of a possible skin cancer, usually after seeing their towns cancer-identification-trained nurse.
Thind et al (2011) [34]	Scotland	Provider education, teledermatology	No	54	GPs trained with dermatology as an area of "special interest" were remotely supervised via telehealth.
Tsang et al (2011) [35]	Africa (6 countries)	Teledermatology	No	2	Teledermatopathology (microscopic examination of skin biopsy specimens) were sent as part of telemedicine consultations as part of the African Teledermatology Project.

Table 1: Included 28 studies assessed for models of skin cancer screening, diagnosis, and management.

[1]Total includes pre-cancerous lesions or lesions very close in appearance to skin cancers, for example dysplastic naevi or actinic keratoses. Assessment of other dermatological conditions (for example, Kaposi's sarcomas and psoriasis) have not been included. Separate lesions have been counted separately, even if found on the same patient. In studies containing both metropolitan and rural or isolated patient populations, only lesions for the rural patient cohort have been represented. For randomised controlled studies in which the control cohort underwent a "standard" model of care, only figures for the randomised cohort have been included. Lesions assessed as part of an education session have not been counted.

[2]Figures for lesions assessed or diagnosed are unavailable, however 225 consultations were had across the study period of 1-year.

[3]While figures for lesions assessed or diagnosed are unavailable, this study included 153 rural women performing skin self-examinations, and 151 rural women randomised to a control (standard treatment) cohort.

Discussion

This review aimed to identify models being used to screen for, diagnose and manage skin cancers in rural settings. The twenty-eight studies included in this review described several models, ranging from upskilling health professionals, to fly-in-fly-out programmes, educating community members to recognise their own potential skin cancers and teledermatology. While each model intended to address challenges in skin cancer management in rural contexts, included models were either unable to encompass the entire continuum from screening, diagnosis, treatment, and surveillance of skin cancers in rural settings, or did so with difficulty.

The most represented model involved teledermatology (with images captured via a camera or dermatoscope, either via store-and--forward or transmitted during a consultation), or microscope (telepathology). Teledermatology has been trialled successfully within rural Australian contexts as a triaging system for skin lesions; inclusive of potentially cancerous or non-cancerous lesions [36]. Practice guidelines for use of teledermatology have been developed and the 'Tele-Derm National' program (an online system inclusive of an educational resource and a system for rural doctors to submit photos or features from a clinical history for review by an experienced dermatologist) operates in regional areas [1, 37].

Nineteen of the included studies used teledermatology, which was reported to be feasible, able to address access barriers for rural patients including need to travel, extended waiting times and out-of-pocket costs [10, 11, 14, 16, 17, 22-30, 32-35]. In most studies, teledermatology was used by GPs (and in one study, nurses [11]) to seek diagnostic support or management advice. None of the included studies involved patients using their own devices to send images to dermatologists, although reports using this approach do exist [38].

Despite the advantages offered in rural contexts, teledermatology cannot address all challenges of providing skin cancer care in rural areas (as per box 1) and little research has investigated teledermatology specifically in relation to skin cancer. For example, only 6 of the 19 studies which included teledermatology were skin-cancer-specific (table 1). Practitioners may be reluctant to use teledermatology in skin cancer screening due to the risk of missing a melanoma or other cancer, as well as personal preference for a more "traditional" approach to skin cancer diagnosis [20, 34, 39]. Teledermatology can also be less useful for rarer lesions (eg. non-pigmented melanomas) or patients with some skin types [20, 34]. In addition, considerations must be made regarding training requirements, equipment needs, potential delays in diagnosis and increased costs to patients and practitioners associated with telemedicine [40]. In one Australian study, Moffatt and Eley [39] found funding be a major barrier to practitioner uptake for telemedicine, highlighting that this model can be more task-intensive and costly for practitioners, and is largely un-renumerated by Medicare [36]. In the United States, a survey of almost 600 dermatologists found similar barriers (technological issues, financial renumeration, and concerns regarding liability and regulations) regarding uptake of telemedicine specifically in a dermatologic context [41]. It has also been highlighted that teledermatology alone fails to allow for a 'complete' skin cancer service inclusive of lymph node checks, full skin and tactile examinations, biopsy or excision [36]. These challenges may explain why integration of teledermatology for skin cancers into mainstream practice to date has been fragmented, slow and often not sustained [40]. Therefore, while teledermatology has great potential as a triaging and diagnostic tool, more research, particularly Australian-based, is required.

Box 1: Benefits and challenges of teledermatology found.	
Benefits	Accurate [20, 29, 30, 32, 34]Satisfactory to practitioners [24]Feasible [10, 14, 17, 20, 22, 24, 25, 27, 29, 30, 34]Reduces referrals [14, 16, 22, 25-28, 34], need to travel [14, 16, 22, 25-28, 34] and waiting times [14, 22, 24, 26-28]Educationally beneficial for patients and practitioners [10, 16, 34]Reduces costs (to the healthcare system and individual) [22, 27]
Challenges	Less experienced users may see less benefits [14, 20]Real-time/video-conferencing dermatology could be challenging to actualise[14]Malignant lesions may be difficult to diagnose, especially for darker skin tones[20, 34]

Box1

An alternate model inclusive of screening, diagnosis and initial treatment involves trained doctors visiting regions of need. Of the included studies, a one-day fly-in-fly-out service [19], visiting dermatologists [9, 10, 17] and a mobile prevention unit [21] were represented. In Australia, the Lions Club has sponsored mobile vehicles transporting trained community volunteers (dermatoscopists) across remote parts of Australia to perform skin surveys and refer suspected cancers to GPs for further investigation [42]. In Switzerland, the 'Solmobile' initiative for skin cancer screening - a mobile unit transporting dermatologists across Switzerland to perform skin assessments and manage possible skin cancers free-of-charge - has been reported [21].

These types of models tend to be hampered by their temporary nature, or lack of continuity of care. In one study, specialists visited once per year [21] and while patients preferred this to travelling for year-round care, the question of whether accepting a 'better than nothing' approach for a population is appropriate, particularly for a potentially time-critical condition such as melanoma. These types of models can be complicated by logistical issues such as weather and aircraft availability, and continuity of care can be challenging to deliver [19]. In addition, patients may still be required to travel for more specialised testing or treatment [9]. Some models which involved mobile units were dependent on volunteer staff [9, 10, 17], which may not be sustainable longer term.

Whilst these models can assist from screening through to skin cancer management, they may be unnecessary if local doctors could be trained and supported in rural areas. GPs provide comprehensive medical care and patients benefit from a continuing therapeutic relationship, which may not be possible to deliver via temporary-intervention models of care. Skin-cancer-specific GP training has been associated with earlier detection of skin cancers [43], and increased diagnostic accuracy, which can avoid unnecessary removal of benign lesions and unnecessary referrals [10]. As one-third of dermatological presentations to GPs involve skin cancers [44], improved confidence and diagnostic accuracy, and safe management of melanoma would presumably enhance health outcomes [31]. In the UK, a diploma qualification is available to GPs with a special interest in dermatology [34], and is similar to the Certificate of Primary Care Dermatology offered by the Royal Australian College of General Practitioners (RACGP) in Australia [7].

Another model involved the upskilling of nurses, including annual nurse-led skin cancer screening programs and nurse-led dermatology clinics involving teledermatology and referral pathways [10, 12, 13, 21]. Nurses are critically important to meeting the healthcare needs of rural Australians, and it has been reported that nurse-led models for other health conditions are associated with faster access, reduced referrals, and improved patient education and awareness [1]. Nurse practitioners have been utilised for skin cancer screening in metropolitan regions of the United States [12], and pharmacists have been used to triage for skin cancer risk factors in Spain [45]. Although these models have shown promise in terms of earlier skin cancer detection and improved convenience for patients [45], more research is required to evaluate the role of such collaborative arrangements in skin cancer management, as well as potential challenges such as diagnostic inaccuracy [1]. Furthermore, when considering upskilling of health professionals of any discipline, workload and time constraints for consultations, practitioner support, resources, and infrastructure (including access to dermatologists) need to be considered [1].

The final model of skin cancer care involved planned skin examinations, and included a 1-day-per year model [15] and routine

skin cancer checks in a general practice setting [5]. Annual skin cancer screening checks can be financially viable for clinics, as well as being an effective public health measure [15]. GP-based routine skin examinations may improve patient outcomes and facilitate local skin cancer management in rural settings [5]. Opportunistic skin cancer screening is common, and using risk stratifications to expand the criteria for populations suitable for skin cancer screening may be appropriate [46]. Further research into the feasibility and impact of these approaches is essential, but needs to be cognisant of persistent difficulties with provision of primary healthcare services across rural Australia [47].

Key challenges for all models included patient awareness, engagement and motivation. Most of our included studies depended on patients presenting for assessment of a self-identified, potentially suspicious lesion. This highlights the crucial role of community education in skin cancer identification. Metropolitan studies have involved training melanoma survivors and their partners to identify skin cancers, provision of video education modules, and community skin check competitions to encourage learning [48]. We found one randomised controlled trial involving provision of education of women with a personal or family history of melanoma, past experiences of sunburn, or other factors associated with an increased risk of melanoma. Women involved in the intervention group were less likely to seek visits with benign diagnoses (eg. seborrheic keratosis), while still presenting early for health care with melanoma in situ and atypical nevi. Women in this group were also more likely to check other people for concerning moles, and reliably obtained smartphone pictures of concerning moles, showing potential for teledermatology involvement [18].

Limitations

It is important to note that despite a thorough search of relevant models internationally, only twenty-eight studies employed in rural or regions without a dermatologist workforce were identified. It is possible that by restricting articles to English-language and peer-reviewed articles that other useful models may have been excluded. Models relating to general dermatology may have been removed by requiring 'skin cancer' as a key word in the title or abstract in the search function.

There was vast heterogeneity between studies. For example, levels of training and experience between health professionals using teledermatology was highly variable. Sample sizes were also highly variable (between 2 and 45872 skin cancers diagnosed) across studies [21, 33, 35]. Furthermore, only one study appeared to include aformal process to record relevant clinical history (eg. work in agriculture, family history of skin cancer) and a description of the characteristics of the lesion (raised or flat, lesion size, time of development) to aid diagnostic accuracy in teledermatology [20].

Applicability to the Australian Context

Healthcare systems represented in this study varied widely by country, in terms of the role of nurse between (and even within) healthcare systems, as did cultural and medical approaches to suspicious skin lesions and standard method of skin cancer management.

Implications for Clinical Practice

Education of patients, the community and health professionals remain key in screening and diagnosing skin lesions. Utility and feasibility of teledermatology has been widely reported by studies in this review, although its capacity tends to be limited as a triaging tool unless a practising health professional qualified in managing skin cancers is available locally. Treatment for skin cancers therefore depends on the level of qualification of local practitioners – wherein practitioners lacking adequate training or confidence need to refer, and local qualified practitioners can prescribe topical therapies to treat skin cancers or perform procedures (including cryotherapy and excisions) safely. Temporary relocation of qualified health professionals and upskilling of GPs and nurses benefits patients in that a complete assessment from screening through to management of a skin cancer can be actualised, however more research is required in order to assess the feasibility of these models, as well as implications for already stretched workforces.

Implications for Research

Further research into the following key areas is recommended:

- The risk of missing skin cancers with teledermatology (incidental or otherwise)
- Teledermatology feasibility and uptake in Australia (metropolitan and rural), and factors associated with implementation
- Upskilling of nurses in recognising and/or managing skin cancers
- Conversely, pathways involving GPs and the benefits and disadvantages of this model (eg. opportunistic health checks, waiting times for GP appointments)

Of the models identified, teledermatology was used most widely and was perceived to be feasible and useful as a screening and diagnostic tool in a rural context. GP-based models could be most comprehensive, being able to address skin cancer screening and diagnosis as well as provide actual management of formed or forming cancers. Other models included visiting doctors, upskilling and educating health professionals (doctors, nurses and allied health), annual skin cancer screening days and patient and community member education. A combination of all approaches is likely needed, and more Australian-based research is required to demonstrate effectiveness and feasibility in a local context.

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