Title: Nurse-led models of service delivery for skin cancer detection: a systematic review.

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AUTHORS CONTRIBUTIONS:

All authors, except Abdulrahman Shadeed, contributed to the initial conceptualisation of the study and the development of the study protocol in partnership with other collaborators. Leila Kattach identified relevant articles and independently screened them alongside Abdulrahman Shadeed. The final list of articles for inclusion was determined through consultation with Steven Ersser and Heidi Singleton. Quality appraisal of the included studies was jointly conducted by Leila Kattach and Heidi Singleton. Data extraction was carried out by Leila Kattach and subsequently reviewed by Heidi Singleton and Debbie Holley. All authors participated in data interpretation, manuscript revision, and approved the final submitted version.

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CONFLICT OF INTEREST STATEMENT:

No conflict of interest has been declared by the author(s).

ABSTRACT

Aim: To consolidate evidence on nurse-led models for skin cancer detection by focusing on their roles, comparing their effectiveness to physician-led care, and highlighting any value-added benefits.

Design: Systematic review methodology with narrative synthesis.

Data sources: MEDLINE Complete, PubMed, Embase, CINAHL Complete, ScienceDirect, Scopus, BNI, LILACS, PsycINFO, Trip Medical Database, ERIC, EThOS, CDSR, WoS, Google Scholar, ClinicalTrials.gov, ICTRP, CENTRAL, and the website 'Getting It Right First Time'.

Methods: This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist. Studies between January 1992 and September 2024 were evaluated using the Joanna Briggs Institute Critical Appraisal Checklists. The search encompassed both peer-reviewed and grey literature; however, no grey literature met the inclusion criteria.

Results: Of the 6,680 records screened, six studies met the inclusion criteria, involving 3,325 patients across England, New Zealand, and the United States. These studies focused on nurse-led models of care for skin cancer, assessing outcomes such as diagnostic accuracy, treatment effectiveness, cost savings, waiting times, access to care, and patient satisfaction. While none directly compared nurse-led to dermatologist-led models, one study demonstrated comparable diagnostic accuracy between nurses and ophthalmologists. Nurse-led models were shown to effectively substitute for or complement physician-led care, though only one study was authored by a nurse consultant, highlighting a gap in nursing-led research. Service users favoured community-based, nurse-led care for its accessibility, convenience, and cost-effectiveness, with health education noted as an added benefit in one study.

Conclusion: Nurse-led models demonstrate potential for high diagnostic accuracy in skin cancer, effective treatment delivery, and enhanced patient education on skin self-examination. While role delineation remains a challenge, nurses play a critical role in supporting dermatologists in addressing the increasing referral demands associated with skin cancer care.

Patient Contribution:
A patient representative with lived experience of melanoma contributed to the review protocol.

KEYWORDS: Assessment, Clinical Effectiveness, Clinical Nurse Specialist, Dermatology, Evidence-based Practice, Health Education, Advanced Practice, Nurse Practitioners, Policy, Nursing Diagnosis.

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TWEETABLE ABSTRACT: Changing tradition: Expert nurse-led models are transforming skin cancer care, leading on accessibility, innovation and high-quality patient outcomes.

PROSPERO REGISTRATION NUMBER:
The systematic review protocol (registration number: CRD42023448950) was developed in collaboration with a patient representative with lived experience of melanoma, alongside academic experts in dermatology nursing and specialised dermatology clinicians.

Impact Statement:
Nurse-led models demonstrate diagnostic accuracy in identifying skin lesions, including skin cancer, while contributing to treatment, patient education, and follow-up care. Despite their growing role in skin cancer management, greater dissemination and publication of their outcomes are needed to inform clinical practice. This review highlights the importance of standardising nurse-led approaches into scalable frameworks to support dermatologists, enhance patient outcomes, and ensure consistent care standards in skin cancer. Further evaluation is required to assess their efficiency, cost-effectiveness, and implementation across diverse healthcare settings.

1. INTRODUCTION

Skin cancer stems from cellular DNA damage that instigates mutations resulting in the dysregulated proliferation of aberrant skin cells within the epidermis (Hasan et al. 2023). These mutations propagate rapidly, ultimately forming malignant tumours known as skin cancer. The two principal categories of skin cancer are melanoma, originating from melanocytes and potentially fatal if diagnosed late, and non-melanoma skin cancers, including basal cell carcinoma, squamous cell carcinoma, and rarer variants (Berry 2016; Cancer Research UK 2023).

Individuals with lighter skin tones are predominantly affected, as their lower levels of photoprotective melanin make them more susceptible to ultraviolet radiation and, consequently, skin cancer (Garbe et al. 2021; Padovese et al. 2018; Schadendorf et al. 2018). Ultraviolet radiation, the most prevalent yet modifiable cause of skin cancer, has been well-documented (D'Orazio et al. 2013; Schadendorf et al. 2018). Early detection improves the prognosis for non-melanoma skin cancer (Didona et al. 2018), and thinner melanomas lead to better treatment outcomes (Swetter and Geller 2014). Skin cancer ranks as the 17th most common cancer globally and is the 14th most common cancer in both men and women (World Cancer Research Fund 2024). In 2022, 331,722 new cases of skin cancer were reported worldwide (World Cancer Research Fund 2024).

Cutaneous melanoma, a significant subset of skin cancer, accounts for approximately 287,723 cases annually, representing 1.6% of all newly diagnosed malignant cancers (Bray et al. 2018). Melanoma is also responsible for 60,712 deaths each year, contributing to 0.6% of global cancer-related mortalities (Bray et al. 2018). Non-melanoma skin cancer comprises 5.8% (1,042,056) of all new cancer cases annually and accounts for 0.7% (65,155) of cancer deaths (Bray et al. 2018). The global burden of skin cancer, with notably high incidence rates in countries such as Australia, the United States, and Germany (World Cancer Research Fund 2024), highlights the urgent need for innovative care models adaptable to diverse healthcare systems worldwide.

Climate change has numerous environmental consequences, including rising global CO2 emissions, sea-level rise, increasing temperatures and extreme weather events, all of which profoundly impact human health (Costello et al. 2009; Watts et al. 2021). Ozone layer depletion, driven by climate change, increases exposure to harmful ultraviolet radiation, particularly ultraviolet B radiation (Watson et al. 2024), which contributes to the rising incidence of skin cancer (Flynn et al. 2023a). Air pollutants, such as polycyclic aromatic hydrocarbons and phthalates, exacerbate this issue by inducing inflammation and disrupting skin barrier functions, further contributing to skin carcinogenesis (Flynn et al. 2023a). Flynn et al. (2023b) reviewed the impact of climate change on cutaneous carcinogenesis, highlighting the rising incidence of skin cancer and its link to ultraviolet radiation. The study also outlined strategies for dermatologists to reduce carbon footprints and lead in climate advocacy.

Recognised by the World Health Organization (2023) as the most significant threat to human health, climate change is associated with deteriorating health outcomes, emphasising the critical need for comprehensive mitigation effort (Rocque et al. 2021). Although climate change's role in skin cancer is well-recognised, further longitudinal studies are needed to quantify its specific impact across different regions and populations (Rocque et al. 2021). Meanwhile, emerging technologies, such as artificial intelligence, show promise in enhancing skin cancer detection and diagnosis, complementing both traditional and nurse-led care (Stanford Medicine 2024). However, the adoption of artificial intelligence faces significant barriers, including a lack of robust clinical trials, challenges in workflow integration, and insufficient evidence supporting consumer-focused applications (Brancaccio et al. 2024).

Nurses play a recognised and pivotal role across health care sectors, being the ‘backbone’ of healthcare worldwide and delivering care in diverse roles and contexts (The Lancet 2019). Nurses and midwives constitute nearly 50% of the global health workforce and of the 43.5 million health workers globally, an estimated 20.7 million are nurses and midwives (WHO 2017). Nursing is crucial for addressing demographic changes and growing healthcare demands (The Lancet 2019). Climate change necessitates a holistic approach to care, which nurses are well positioned to

provide (The Lancet 2019). Nurse-led clinics can effectively expand capacity for managing non-communicable diseases (Doherty et al. 2018; The Lancet 2019) and offer effective, cost-efficient care (Doherty et al. 2018). They are also adaptable and scalable, making them well-suited to address the global demand for skin cancer services, particularly in low-resource settings with limited physician availability.

Advanced practice nursing, an innovative and evolving field, aims to address care gaps and the increasing demand for healthcare services, driven by global challenges like climate change, an ageing population, and rising non-communicable diseases (Ladd et al. 2020). However, these roles have emerged unequally worldwide in response to local care needs, lacking consistent support for extended roles (Kilpatrick et al. 2023). Advanced nurse practitioner-led care, which has increasingly replaced physician-led care in various settings, is well received by patients (Htay and Whitehead 2021). Research on advanced nursing practice and its association with improved patient outcomes continues to grow, highlighting the significant contributions these nurses make across diverse healthcare settings (Poghosyan and Maier 2022). Nurse-led initiatives can improve the uptake of early cancer detection, increase understanding, promote confidence in early detection, and enable timely identification of precancerous lesions (Li et al. 2020). Studies show that patients widely accept nurse-led case management (McParland et al. 2022).

Educating and engaging patients in managing their care has been shown to enhance patient-centred outcomes, such as improved treatment adherence and quality of life (Doherty et al. 2018). Dermatology nurse specialists have been found to foster patient trust and engagement through the provision of tailored education, training, and psychosocial support (van Os-Medendorp et al. 2020). A dermatology nurse-led education programme developed in the United Kingdom, involving group education and social learning for chronic dermatoses, was positively received by parents of affected children. Preliminary findings indicated positive clinical outcomes and improvements in quality of life (Ersser 2013; Jackson et al. 2014). Nurse-led care has been shown to have the potential to benefit not only service users but also healthcare services (Doherty et al. 2018; Htay and Whitehead 2021). Healthcare organisations globally implement varying nurse-led care models, which reflect

diverse patient needs, health system structures, clinician preferences (Loescher et al. 2011), and available resources.

This systematic review aims to address the growing demand for skin cancer services by collating, examining, appraising, and synthesising available evidence to assess whether nurse-led models for skin cancer detection and management are as effective as traditional physician-led care. Specifically, this review seeks to answer the following questions:

- Do nurse-led models of service delivery for skin cancer effectively provide one or more of the following components - assessment, treatment, or education?
- Are the different nurse-led models effective compared to physician-led care (standard care)?
- Compared to standard care, do the models offer additional value-added care for patients?

2. METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al. 2021) for reporting systematic reviews and their abstracts. The completed PRISMA checklists specific to this study are available in Supplementary Documents 1a and 1b. Furthermore, the review was registered with PROSPERO (registration number: CRD42023448950).

The protocol was developed in collaboration with a patient representative with lived experience of melanoma, academic experts, and specialist dermatology clinicians.

2.1. Eligibility criteria

Studies were selected based on the following criteria:

2.1.1. Types of studies

Except for pilot studies, all qualitative, quantitative, and mixed-methods studies were considered. The selection process was not restricted to peer-reviewed publications, and the search included grey literature, ensuring a comprehensive inclusion of relevant information.

2.1.2. Types of participants

Service users of all age groups and all skin types according to the Fitzpatrick (1988) skin types I-VI, requiring skin cancer assessment, treatment, and/or education.

2.1.3. Types of interventions/comparators

The review focused on studies of nurse-led models or interventions, comparing them to physician-led care, as well as models delivered in tandem with or replacing physician-led care. The included studies examined nurse-led models that provided one or more of the following components: assessment, treatment, or education for

skin cancer. Various treatment modalities were included, such as photodynamic therapy, skin surgery, cryotherapy, topical treatments, and educational interventions.

2.1.4. Types of outcomes

Nurse-led models were evaluated across several outcomes based on the available data within the included studies. These outcomes included whether a full skin examination was performed and whether subsequent treatment was provided. The reliability of nurse-led diagnostics was assessed by comparing the diagnostic accuracy of assessments conducted by nurses with those performed by physicians. The review also assessed the timeliness of care delivery, encompassing the period from assessment to diagnosis, initiation of treatment, referral, or discharge, as well as cost-effectiveness. The review identified value-added care for patients provided in addition to standard care equivalence and their impact on patient satisfaction and outcomes. Outcomes were collected as reported in individual studies and compared when similarities were observed.

2.1.5. Types of setting

Selected studies were not limited to hospital settings or restricted by medical specialty, ensuring inclusion of research across various medical fields. No restrictions were applied regarding the type of skin cancer, enabling a comprehensive review.

2.2. Information sources

2.2.1. Electronic searches

A comprehensive literature search was undertaken to identify both published and unpublished studies across relevant electronic databases, which included: MEDLINE Complete, PubMed, Embase, CINAHL Complete, Science Direct, Scopus, British Nursing Index, Latin American and Caribbean Health Sciences Literature, PsycINFO, Education Resource Information Centre, Trip Medical, E-Theses Online

Service, Web of Science, and the Cochrane Database of Systematic Reviews. Trial registries were also searched, including ClinicalTrial.gov, the World Health Organization International Clinical Trials Registry Platform, and Cochrane Central Register of Controlled Trials. The search engine Google Scholar and the website 'Getting It Right First Time' (GIRFT 2021) were also searched.

2.2.2. Searching other resources

Grey literature, such as abstracts and conference papers, was requested directly from international dermatology nursing organisations via email. To ensure comprehensive coverage, the citations and reference lists of selected studies were thoroughly examined to identify additional relevant papers (Bowen 2008).

2.3. Search strategy

The search strategy applied the PICO framework, comprising: Population, Intervention, Comparator/s, Outcomes (Higgins and Green 2011) and the search terms included a combination of the keywords as well as their synonyms. The key search terms were:

Skin cancer AND Nurs or Nurs* led*

Medical Subject Headings indexing, Boolean operators, wildcards, and truncation were systematically applied where available (see Supplementary Document 2 for details on searches and search dates).

2.4. Data collection and analysis

2.4.1. Selection of studies

All retrieved abstracts, studies, and citations were collated in the EndNote reference management database. Duplicates were systematically removed, and a staged review process began with a preliminary screening of titles and abstracts in EndNote to exclude irrelevant articles (e.g., studies focusing on breast cancer). Any articles

that mentioned skin cancer or nurse-led care in the title or abstract were transferred into the software Covidence. Covidence was used to streamline the review process and adhere to best practices for systematic review methodology. The specific inclusion and exclusion criteria, along with detailed definitions of eligibility parameters, are outlined in Table 1. Using Covidence, two reviewers (1 and 6) independently reviewed the titles and abstracts of each paper, and irrelevant papers were removed. The full texts of the remaining articles were independently reviewed, with selection justifications recorded. Any discrepancies regarding eligibility were resolved through group discussion (1, 2, 3 and 4), and consensus was reached.

2.4.2. Inclusion criteria

The literature search focused on full-text studies in English, made available between 1 January 1992 and 10 September 2024. The year 1992 was selected as the starting point because it marks a significant milestone in the advancement of nursing practice and expanded roles (Rushforth and McDonald 2004). The search included peer-reviewed and grey literature to ensure comprehensive coverage and reduce publication bias.

2.4.3. Exclusion criteria

Excluded studies included those of nurse-led models delivering care to cancer patients with different types of cancers combined (e.g. skin and lung cancer patients consulted in one clinic) and models administering immunotherapy or targeted therapy to patients with metastatic melanoma, (e.g. managing side effects or adverse events). Pilot studies were excluded, and studies of models delivered by non-medical registered professionals (e.g., pharmacists) or unregistered professionals (e.g., physician associates and health care assistants), and studies with outcome data from combined groups of registered or unregistered non-medical professionals.

2.4.4. Assessment of risk of bias in included studies

Grey literature was included in the search strategy; however, no sources met the inclusion criteria and were consequently not evaluated. If relevant grey literature had been identified, it would have been appraised for quality using the Authority, Accuracy, Coverage, Objectivity, Date, and Significance checklist (Tyndall 2010). The papers were meticulously read and critically appraised (Aveyard and Bradbury-Jones 2019) to assess the methodological robustness, reliability, focus, and overall quality of the studies in relation to the research questions. A thorough evaluation was conducted to identify and address potential biases in study design, conduct, analysis, and presentation (Moola et al. 2020). Two authors (1 and 2) independently evaluated the methodological rigour and quality of the included studies using the Joanna Briggs Institute Critical Appraisal Tools for Case Series (Munn et al. 2020), Cohort (Moola et al. 2020), Case Control (Moola et al. 2020), and Quasi-Experimental studies (Tufanaru et al. 2020). The details of the quality appraisal are provided in Supplementary Document 3.

The overall quality grading and justification for each study are detailed in Table 3, while Table 2 summarises the strengths and weaknesses of each study.

2.4.5. Data synthesis

To ensure a rigorous and transparent narrative synthesis while minimising bias from subjective judgments, the review was guided by the four key elements outlined by Popay et al. (2006). An initial framework was developed to categorise and understand the functioning of nurse-led models, including whether they replace or complement physician care, their effectiveness, the populations that benefit most, and the settings in which they are most useful. The selected studies were tabulated to identify key similarities and differences, translating patterns into themes and exploring relationships in the data. An iterative process was used to reassess each paper and refine the synthesis, ultimately constructing a narrative that directly addressed the research questions of the review.

2.4.6. Data extraction

The principal reviewer (1) compiled data from the six studies into a Microsoft Excel spreadsheet, categorising the results in Table 2. For accuracy and consistency, two other reviewers (1 and 4) checked the data. Categories included geographical location, setting, data collection method, nurse-led model type, and nurse designation. Key themes such as full skin examination, treatment, health education, care equivalence to physicians, cost-effectiveness, service user feedback, and value-added care for patients were identified. A summary of the demographics is presented in Table 4.

2.4.7. Outcomes and prioritisation

Outcomes were reported as presented in the six individual studies, without pre-determination prior to the literature search. As key themes emerged, other study findings were categorised according to outcome type. No specific outcomes were prioritised, ensuring a thorough review of the available evidence.

3. FINDINGS

Six studies (Clayton et al. 2006; Jones et al. 2021; Jones and Mullen 2014; Lim et al. 2012; Mohite et al. 2016; Oliveria et al. 2004) met the eligibility criteria. The PRISMA flow diagram (Figure 1) outlines the search results at each stage of the screening process. Information sources included databases (n=7,698), registries (n=136), websites (n=1), organisations (n=0), and forward and backward citation searches (n=64). From a total of 7,899 hits, 1,219 duplicates were removed, leaving 6,680 records for title and abstract screening. Of these, 93 reports were reviewed in full text, and six studies ultimately met the inclusion criteria (see Supplementary Document 4 for the reference list of articles meeting the inclusion criteria).

Four studies were identified through database and registry searching, and two were located via backward citation searching. The six studies reported outcomes on a total of 3,325 patients in three different countries: England, New Zealand, and the United States. The characteristics of these studies have been summarised, including the study design, type of nurse-led models, comparisons to physician-led care

(where available), outcome measures (Table 2), and participant demographics (Table 4). All elements of this review were conducted with a minimum of two reviewers to ensure accuracy and reliability.

3.1. Studies reporting assessment, treatment and/or education

All six studies described either a nurse-led service delivery model (Clayton et al. 2006; Lim et al. 2012; Jones and Mullen 2014; Mohite et al. 2016; Jones et al. 2021) or intervention (Oliveria et al. 2004) delivered partially or entirely by registered nurses. Four studies involved collaboration with secondary care dermatologists (Clayton et al. 2006; Jones et al. 2021; Lim et al. 2012; Oliveria et al. 2004), and one study involved an ophthalmologist (Mohite et al. 2016). One study by Jones and Mullen (2014) described a consultant nurse-led service within secondary care. See Table 5 for a summary of the nurse-led model types.

3.1.1. Assessments and full skin examinations

One study conducted in England (Jones and Mullen 2014) reported that a nurse consultant performed full skin examinations on each patient, detecting additional, unsuspected lesions in 29.1% of patients (n=34). In contrast, Oliveria et al. (2004) in the United States reported that dermatologists conducted baseline skin examinations, with no assessments being performed by nurses. In New Zealand, Lim et al. (2012) and Jones et al. (2021) indicated that dermatologists performed skin examinations if participants were referred to secondary care. However, Jones et al. (2021) noted that clinical nurse specialists identified 107 incidental lesions in community imaging clinics, suggesting that nurses performed skin examinations, although specific details of these examinations were not provided. Lim et al. (2012) pointed out that a limitation of the virtual lesion clinic was the absence of full-body examinations.

In two studies conducted in England (Clayton et al. 2006; Mohite et al. 2016), full skin examinations were not mentioned. Clayton et al. (2006) described nurses administering photodynamic therapy under the direction of dermatologists, who later

assessed treatment success. Mohite et al. (2016) described a study within an ophthalmology service where clinical nurse specialists assessed suspected benign eyelid lesions and following assessment against specific criteria, referred patients to appropriate surgeons. In some cases, they performed surgical removal of benign lesions themselves, as appropriate.

3.1.2. Treatment

The nurse consultant determined that 83 (98%) out of 118 patients assessed required surgical intervention for their lesions (Jones and Mullen 2014). Of these, the nurse consultant operated on 57 (43%) patients, while 17 (14%) received surgical treatment from an advanced nurse practitioner. For patients not requiring surgical intervention, the nurse consultant administered treatment. A total of 35 patients (41%) received cryotherapy (freezing spray treatment) or topical treatment with 5-fluorouracil or imiquimod cream, all of which work by destroying the damaged cells (British Association of Dermatologists 2018; 2022; 2024).
In England, two nurse-led models were described: one involving hospital-based surgical removal of benign eyelid lesions (Mohite et al. 2016), and the other providing photodynamic therapy in both hospital and community settings (Clayton et al. 2006). Additionally, a study by Lim et al. (2012) in New Zealand reported that nurses provided treatments, including cryotherapy and unspecified topical therapies; however, it was unclear whether they also performed minor surgical procedures. The study excluded surgery costs from the financial analysis, as these costs would be similar whether patients were diagnosed at the virtual lesion clinic or in face-to-face clinics. In the study by Jones et al. (2021) conducted in New Zealand, treatments were mentioned but it was unclear whether these were performed by nurses.

3.1.3. Education

Health education was only noted in two studies (Jones and Mullen 2014; Oliveria et al. 2004). Oliveria et al. (2004) described a nurse-led educational intervention, previously outlined in a pilot study (Phelan et al. 2003), where nurses presented a three-minute video on skin self-examination. The video promoted early detection by

systematically guiding patients through each step using imagery and was followed by a question-and-answer session. In contrast, Jones and Mullen (2014) mentioned health education delivery but did not provide specific details.

3.2. Studies reporting effectiveness of nurse-led care compared to physician-led care

3.2.1. Effectiveness

Overall, the studies reviewed consistently demonstrated that nurse-led services were fit for purpose (Jones and Mullen 2014; Mohite et al. 2016; Clayton et al. 2006; Jones et al. 2021; Lim et al. 2012; Oliveria et al. 2004). A high-quality evaluation of a nurse consultant-led basal cell carcinoma clinic in England found that nurses delivered comprehensive care to 89% (n=105) of patients without dermatologist input (Jones and Mullen 2014). Most patients underwent complete excision of their lesion with no follow-up required. Nurses also identified additional lesions during full skin examinations, though no direct comparison with physicians' diagnostic accuracy was made. This study was notable for its clear inclusion criteria and reliable measurement methods, despite some limitations in demographic reporting and statistical analysis.

A retrospective comparative study conducted within a secondary care ophthalmology service in England examined outcomes between nurse-led and physician-led services for skin lesion management (Mohite et al. 2016). The study had clear inclusion criteria, comparable demographic reporting, and appropriate statistical analyses. No significant differences in patient demographics between the two services ($p > 0.05$) were identified. Both services had similar distributions of benign lesions confirmed by histology, with diagnostic accuracy rates of 80% (267/332) for nurse-led services and 79.6% (210/264) for physician-led services. Additionally, the missed malignancy rates were low and comparable between the two groups, at 1.5% (n=4) for physicians and 1.1% (n=4) for nurses ($p > 0.05$).

A small, randomised study compared nurse-led photodynamic therapy in a hospital to community-based therapy, with outcomes assessed by a dermatologist (Clayton et al. 2006). At six months, results were similar between both groups. While the study was rated as moderate quality for demonstrating clear cause-and-effect and having sufficient initial follow-up, limitations were noted. These included inadequate randomisation, where group allocation was based on lesion order, with the first lesions treated in secondary care, followed by subsequent ones in primary care. The study also lacked detailed statistical analysis and had insufficient outcome measures, likely due to a lack of long-term follow-up and a small sample size.

A retrospective study (Jones et al. 2021) compared the effectiveness of a 2020 suspected skin cancer referral pathway with nurse-led virtual lesion clinics from 2016 and 2020. In both services, patients with suspicious skin lesions were assessed virtually by a dermatologist using regional, close-up, and dermoscopic images. In the virtual lesion clinics, specialist nurse melanographers captured images of lesions in a community setting, which were then remotely evaluated by a dermatologist (Jones et al. 2021).The study identified a statistically significant reduction in the median time from referral to advice ($p < 0.001$), with the suspected skin cancer pathway taking four days compared to 42 and 50 days for the virtual lesion clinics in 2020 and 2016, respectively. Dermatologists recommended 'no further action' for 56% (n=298) of lesions in the suspected skin cancer pathway cohort, 57% (n=157) in the 2020 virtual lesion clinic cohort, and 69% (n=471) in the 2016 cohort. Clinic nurse specialists working remotely provided high-quality images using standard cameras, though 5% (n=71) of lesions in the suspected skin cancer pathway were undiagnosable due to poor image quality. The study, assessed as moderate quality, had valid outcome measurements but identified confounding factors. Both groups were recruited from the same population, though potential selection bias existed due to general practitioner triaging for group allocation.

Lim et al. (2012) compared patient flow between a community-based nurse-led virtual lesion clinic and a tertiary hospital face-to-face dermatology clinic. The mean waiting time for an appointment in the face-to-face clinic was 114 days, compared to 39 days for the virtual lesion clinic, representing a 66% reduction in waiting time for the latter. At the start of the study, the mean waiting time for the virtual clinic was 37

days, while the face-to-face group's mean waiting time was 66 days, peaking at a mean of 138 days. Dermatologists remotely assessed 383 lesions in the virtual clinic, compared to 210 in the face-to-face group. Treatment was recommended for fewer patients in the virtual clinic 36.5% (n=73) compared to the face-to-face clinic 60% (n=60), and 59% (n=117) of virtual clinic patients were discharged. The study was rated as low quality due to differences in group recruitment, unclear measurement validity, unidentified confounding factors, incomplete follow-up, and insufficient strategies to address loss to follow-up. Despite these limitations, the outcome measurements were still deemed valid and reliable.

A case-control study (Oliveria et al. 2004) revealed increased adherence to skin self-examination at the 4-month follow-up for both interventions, with the photobook intervention showing superior improvement. The study had a participation rate of 95% (n=100/105). In Group A (teaching intervention with a photobook) and Group B (teaching intervention without a photobook), 86% (n=42) and 84% (n=43) respectively completed the 4-month follow-up. In Group A, 51% (n=25) showed improved skin self-examination at the 4-month follow-up, compared to 17.6% (n=14) in Group B. The photobook intervention had a statistically significant effect ($p < 0.001$) on adherence to skin self-examination. Additionally, 10.2% (n=5) in Group A reported skin examination three or more times at baseline, increasing to 61.2% (n=30) at the 4-month follow-up ($p = 0.039$). In Group B, nearly 20% (n=10) reported skin examination three or more times at baseline, rising to 37% (n=19) at the 4-month follow-up ($p = 0.63$). The increase was 51% in Group A and 17.6% in Group B, a statistically significant difference ($p < 0.001$). The study by Oliveria et al. (2004) was rated as moderate quality, with strengths in case-control matching and valid outcome assessments. However, there was a lack of clarity regarding confounding factors, and the short exposure period limited the ability to assess the long-term effects of the photobook on self-skin examination monitoring.

3.2.2. Service user feedback

In two studies service user feedback was absent (Jones et al. 2021; Mohite et al. 2016). Oliveria et al. (2004) mentioned that patient acceptance of the photographs

was high but did not specify the method for measuring this acceptance. In the study by Jones and Mullen (2014), qualitative patient testimonies were collected by a clinical nurse specialist via telephone and follow-up clinics. Patient testimonies included feelings of reassurance throughout treatment, satisfaction with scarring, appreciation for the prompt identification and treatment of serious skin cancers, shorter waiting times relative to prior experiences, and increased confidence in treatments due to thorough explanations. Key themes from the feedback highlighted a lack of clarity surrounding the nurse consultant's role. Despite this, patients shared positive views about the care they received, often expressing pleasant surprise at the comprehensive and independent care provided by the nurse consultant (Jones and Mullen, 2014).

A study by Clayton et al. (2006) compared hospital-administered photodynamic therapy with community-based photodynamic therapy, involving 25 patients in each group. The average age of patients receiving treatment was 71 years. The study highlighted logistical challenges specific to hospital-based care, such as patients needing to cancel entire-day commitments for treatment and relying on relatives for transportation.

Community-treated patients stayed home during the cream absorption phase (5-aminolaevulinic acid), leading to shorter treatment times at the health centre. All 25 completed therapy within 1–2 hours, with 88% finishing in under an hour. In contrast, hospital-treated patients experienced longer durations due to attending for photosensitiser application, with 8% spending over 6 hours, 64% between 3–6 hours, and 28% finishing in under 3 hours. Patients preferred community-based treatment for its convenience and accessibility, with 96% (n=24) of community-treated patients and 52% (n=13) of hospital-treated patients favouring the local health centre.

The survey data from Lim et al. (2012) compared service user perceptions of the nurse-led virtual lesion clinics and the face-to-face physician-led clinics, using a rating scale from 1 (poor) to 5 (excellent) across several key elements. Respondents rated the waiting time for appointments significantly higher at the virtual lesion clinic (4.0) compared to the face-to-face clinic (2.9), indicating shorter and more favourable

waiting times. Similarly, convenience and waiting times at the clinic were perceived more favourably at the virtual lesion clinic (4.1-4.7) than at the face-to-face clinic (3.3-3.8). Service users also reported higher satisfaction with the time spent with health professionals and the quality of explanations provided at the virtual lesion clinic (4.5) compared to the face-to-face clinic (4.1). The overall experience of the service was rated significantly higher at the nurse-led virtual lesion clinic (4.5) compared to the physician-led face-to-face clinic (3.8), suggesting that users of the virtual clinic reported a more positive experience.

3.2.3. Cost effectiveness

Cost-effectiveness was not addressed in two of the six studies (Jones et al. 2021; Oliveria et al. 2004). The Jones and Mullen (2014) study on a nurse-led model carried out in England found it to be comparable to a medical consultant-led service, delivering equivalent care while requiring less funding. Although they claimed the service was cost-effective, no financial data or analysis was provided. Another advantage of the nurse-led model was that it created capacity for additional physician-led clinics.

In a National Health Service ophthalmology service in England, which involved examining suspicious skin lesions, an experienced nurse was reported to be approximately 55% less costly than a consultant or senior staff grade per minor operation list, resulting in an 18–23% cost saving per 8-patient lesion list (Mohite et al. 2016). The study suggested that employing nurses for minor operation lists could free up physician time for complex cases; however, the authors did not provide detailed cost analyses or clinic comparisons.

Clayton et al. (2006) provided a cost breakdown for a single photodynamic therapy treatment within the National Health Service in England, detailing expenses for light administration (£80), sensitising agent (£24 per lesion), nursing (£10/hour), and consumables (£5). Costs were lower in the primary care group due to reduced transport expenses, as 10 out of 25 hospital-treated patients required an ambulance

(£75 per trip). Some patients relied on friends or family for transport when ambulances were unavailable.

Significant savings were achieved through virtual lesion clinics, as reported by Lim et al. (2012). The financial analysis included total patient interactions, diagnostic visits, and follow-up nurse treatment clinics. Costings from the District Health Board's business unit in New Zealand revealed a contracted fee per patient for the virtual clinic. Nurse-led treatments like cryotherapy and topical therapy saved $42.00 per patient, reducing costs by 14%.

3.3. Studies Reporting Value-Added Care in Nurse-Led Models Compared to Physician-Led Care (Standard Care)

Value-added care in nurse-led skin cancer management refers to services provided in addition to standard care equivalence, such as health education and accessible, community-based care. Mohite et al. (2016) compared diagnostic accuracy between clinical nurse specialists and physicians but did not address value-added care. The remaining studies (Clayton et al. 2006; Jones et al. 2021; Jones and Mullen 2014; Lim et al. 2012; Oliveria et al. 2004) did not directly compare nurse-led to physician-led care, limiting assessment of value-added care. However, nurse-led models effectively delivered the required care. Benefits included reduced travel times (Clayton et al. 2006; Jones et al. 2021; Lim et al. 2012), shorter waiting times (Jones and Mullen 2014; Lim et al. 2012), shorter treatment times (Clayton et al. 2006), increased access (Clayton et al. 2006; Jones and Mullen 2014; Lim et al. 2012), health education (Jones and Mullen 2014), and reduced patient costs (Clayton et al. 2006; Lim et al. 2012).

4. DISCUSSION

This review evaluates international nurse-led models for skin cancer assessment, treatment, and education, comparing their effectiveness to standard care. The heterogeneity and variability of data across studies precluded a quantitative synthesis. Consequently, a narrative synthesis was undertaken, potentially limiting

the generalisability of the findings and highlighting the need for more standardised evaluation frameworks. Courtenay and Carey (2007) highlighted the significant benefits of nurse interventions in dermatology, including reduced condition severity, improved use of topical therapies, faster access to care, fewer referrals, and increased patient knowledge. However, they also noted that some primary care nurses lack confidence, and their educational needs are often unmet. Furthermore, despite generally positive findings, methodological weaknesses and under-researched areas, particularly cost-effectiveness and nurse prescribing, point to the need for further rigorous evaluation. The van Os-Medendorp review (2020) details the role of specialised dermatology nurses in managing moderate to severe atopic dermatitis, emphasising their specific contributions to education, support, and treatment adherence.

The National Institute for Health and Care Excellence (2024) guideline for skin cancer recommends that patients with melanoma, high-risk squamous cell carcinoma, or rare skin cancers have access to a clinical nurse specialist. These specialists manage chronic and complex conditions (Tracey et al. 2020). Nurse consultants, the most advanced role within clinical nursing practice, are involved in expert practice, leadership, education, training, service development, and research (Redwood et al. 2005). Jones and Mullen (2014) reported positive patient feedback regarding care from a nurse consultant, though issues with role clarity were identified. However, this conclusion is drawn from a single study. The 'Getting It Right First Time' dermatology report for England found that 11% of National Health Service trusts have a dermatology nurse consultant in post, 76% offer nurse-led skin cancer clinics, and 23% provide nurse-led clinics specifically for new skin cancer patients (GIRFT 2021). A census of skin cancer specialist nurses in the United Kingdom found that rising referrals and increased demand have led to the expansion of nurse-led clinics, often operating with reduced consultant oversight (Rammanohar 2023).

Clinical nurse specialists perform advanced tasks, including independent non-medical prescribing for specific groups, ordering investigations, and drug monitoring (BDNG 2023). In contrast, advanced nurse practitioners and nurse consultants assume higher-level responsibilities, such as diagnostics and more comprehensive

prescribing (HEE 2017). Health Education England's framework for advanced clinical practice, seeks to promote national consistency in key role elements (HEE 2017). Despite progress, Hardy et al. (2021) highlight ongoing inconsistencies in the descriptions and titles of advanced nursing roles across different healthcare settings and professional groups. In the United States, the National Council of State Boards of Nursing (2024) regulates Advanced Practice Registered Nurses, ensuring they are qualified to assess, diagnose, manage, order tests, and prescribe medications through advanced education and certification. Meanwhile, the United Kingdom's Nursing and Midwifery Council is currently reviewing the need for additional regulation to standardise advanced nursing practice (NMC 2024).

Poghosyan and Maier (2022) emphasise the increasing evidence base demonstrating the effectiveness and quality of advanced practice nursing across multiple stages of implementation and clinical specialties. They point out that while countries like Norway are in the early phases of adopting advanced practice roles, nations such as England and the United States have more established systems, showcasing the successful integration of these roles into healthcare. The International Council of Nurses (ICN 2020) guidelines on Advanced Practice Nursing stress the importance of a shared understanding of roles and responsibilities among key stakeholders, including the public, governments, healthcare professionals, policymakers, educators, and the nursing profession. These guidelines aim to establish policies, frameworks, and strategies to ensure consistency and clarity in Advanced Practice Nursing roles worldwide, helping Advanced Practice Registered Nurses contribute effectively to healthcare needs (Bryant-Lukosius et al. 2017; Carryer et al. 2018). The International Council of Nurses also emphasises the dynamic nature of advanced practice nursing, encouraging its continuous development through education, regulation, and practice adjustments to address evolving healthcare demands (International Council of Nurses 2020).

With global skin cancer cases projected to increase (Hasan et al. 2023; Zhang 2021), there is an urgent need to strengthen public health education and expand care capacity. A pilot study in Australia, the "Skin Cancer Assessment Remote Service," focused on personalised education in skin cancer detection, self-examination, sun protection, and the development of nursing skills. It also included

nurse-led assessments using dermatoscopy (Christensen 2019). In the initial pilot, 54 patients were screened; 20% (n=11) were identified as high risk and 79% (n=43) as medium risk for melanoma and non-melanoma skin cancer. Notably, 49% (n=26) of these patients had never been screened before. Nurses successfully identified and treated 6 (n=11%) malignant melanomas, 8 (n=15%) squamous cell carcinomas, and 7 (n=13%) basal cell carcinomas.

Studies confirm that nurses demonstrate high diagnostic accuracy when assessing referred skin lesions (Jones and Mullen 2024; Mohite et al. 2016) and identified previously unsuspected lesions, such as invasive melanoma and squamous cell carcinoma (Jones and Mullen 2014; Jones et al. 2021). Mohite et al. (2016) emphasised the critical role of nurse training in achieving accurate diagnoses, recommending that clinicians pre-vet referrals to ensure appropriate cases for nurse-led services. With pre-vetting, nurse-led services were found to be collaborative, cost-effective, and comparable to physician-led care. Nurses demonstrated high diagnostic accuracy, particularly for benign lesions, and effectively managed smaller, more complex cases, highlighting their level of expertise when provided with adequate training. However, the lack of direct comparisons between nurse-led and dermatologist-led care represents a significant gap. Future research must address this limitation to provide a clearer understanding of their relative effectiveness and cost-efficiency, which would better inform healthcare policy and practice.

Financial analyses have demonstrated significant cost savings for nurse-led virtual lesion clinics compared to face-to-face dermatologist appointments (Lim et al. 2012). Both Jones and Mullen (2014) and Mohite et al. (2016) found nurse-led care to be cost-effective and comparable to consultant-led services. Mohite et al. (2016) reported approximately 50% savings per nurse-led surgical list; however, the details of the cost calculation and included expenses were not provided. Additionally, nurse-led care helped free up consultant physician time for other priority tasks in both studies (Jones and Mullen 2014; Mohite et al. 2016). Nurse-led care increased access to skin cancer services in studies by Clayton et al. (2006), Jones and Mullen (2014), and Lim et al. (2012), with Jones and Mullen (2014) noting that health education was also provided alongside standard care.

Several studies have highlighted other significant benefits of nurse-led skin cancer care, including reduced travel time for patients (Clayton et al. 2006; Jones et al. 2021) and shorter waiting times for appointments (Jones and Mullen 2014; Lim et al. 2012), enhancing both convenience and accessibility.

Nurse-led, community-based photodynamic therapy, administered locally, had treatment times of 1–2 hours compared to the 3–6 hours typically required when delivered in a hospital setting (Clayton et al. 2006). Nurse-led care was found to increase access to care (Clayton et al. 2006; Jones and Mullen 2014; Lim et al. 2012), provide additional health education (Jones and Mullen 2014), and reduced patient costs by offering care closer to home (Clayton et al. 2006; Lim et al. 2012). Community outreach enhances accessibility, particularly for rural patients who face difficulties attending hospital appointments (Clayton et al. 2006). Nurse prescribing, a key element of advanced clinical practice (HEE 2017), is essential in treatment clinics to support the provision of comprehensive patient care.

Health education delivered to patients has been shown to encourage skin self-examination (Oliveria et al. 2004), with females presenting more frequently with smaller lesions (Jones and Mullen 2014). For both sexes, family discussions about sun protection have been associated with increased engagement in sun protection behaviours (Manne et al. 2021). A systematic review and meta-analysis on interventions promoting early skin cancer detection through skin self-examination found that most studies targeted high-risk individuals rather than the general population (Ersser et al. 2019). While some interventions demonstrated improvements in skin self-examination activity and showed potential for facilitating early skin cancer detection, the limited quality of evidence restricted definitive conclusions regarding their clinical impact (Ersser et al. 2019). Oliveria et al. (2004) emphasised the importance of cues to action, such as nurse guidance and personalised photo books, in promoting behaviour change based on the health belief model (Rosenstock et al. 1988).

Systematic self-skin examination has been shown to reduce the incidence of thick lesions, morbidity, and melanoma mortality, with visual aids, such as photographs, enhancing adherence. Nurse-led models address critical gaps in skin cancer care by

supporting physicians in care delivery, providing services that may otherwise be unavailable, ensuring equivalent care, and offering value-added benefits. However, significant evidence gaps persist, highlighting the need for comparative trials, cost analyses, and long-term evaluations to validate the efficacy and scalability of nurse-led models across diverse settings.

4.1 Limitations

A key limitation is that only six studies met the inclusion criteria, narrowing the evidence base and limiting the findings' scope. This hinders definitive conclusions about the comparative effectiveness of nurse-led and dermatologist-led models, which may affect the generalisability of the results. However, this reflects the review's specific focus on studies addressing nurse-led skin cancer care to ensure high relevance. An ophthalmology-based study was also included due to its alignment with the review's objectives on lesion-related care.

The varying quality of the studies, rated as low (n=1), moderate (n=3), and high (n=2), introduces biases and weakens the robustness of the conclusions. Heterogeneity in aims, reporting, and outcomes hindered comparison and synthesis, preventing meta-analysis. The diversity of nurse-led models and variations in outcome measures complicated comparisons with physician-led models, limiting generalisable recommendations and highlighting the need for standardised frameworks to ensure consistent future comparisons.

The multidisciplinary approach in some models (Jones et al. 2021; Lim et al. 2012) made it difficult to delineate the exact roles and contributions of nurses within each service. Notably, physicians were the first authors in four of the six studies (Clayton et al. 2006; Jones et al. 2021; Lim et al. 2012; Mohite 2016), and one study was authored by an epidemiologist (Oliveria et al. 2004). This may have contributed to an underrepresentation of the multifaceted components of nurse-led models, including additional value-added care for patients. In one study, it was unclear whether a full skin examination was provided by the nurse-led service due to incomplete details (Jones et al. 2021).

Three studies had small sample sizes and short durations (Clayton et al. 2006; Jones and Mullen 2014; Oliveria et al. 2004). Notably, Oliveria et al. (2004) had a follow-up period of only four months, which is significant given the focus on adherence to skin self-examination. This raises concerns about the intervention's long-term effectiveness, given that patients typically retain only 20% of medical information and forget 40%–80% shortly after medical encounters (Ley 1979; Richard et al. 2017; Street et al. 2013; Sherlock and Brown 2014).

Cost-effectiveness was claimed in four studies (Clayton et al. 2006; Jones and Mullen 2014; Lim et al. 2012; Mohite 2016); however, only one study (Lim et al. 2012) provided sufficient detail about costings through a financial analysis. This lack of transparency in the remaining studies limits the reliability of the cost-effectiveness claims. To address this, it is crucial for nurses to describe and publish their nurse-led models with detailed, rigorous evaluations, ensuring transparency and evidence-based validation of their safety, efficiency, and cost-effectiveness.

5. CONCLUSION

The global shortage of dermatologists, driven by funding disparities and varying healthcare demands across countries, is expected to persist. This review demonstrates that nurse-led care appears to be a safe, efficient, and cost-effective approach for managing specific aspects of the skin cancer care pathway under both direct and indirect physician supervision. Nurses have the potential to play a pivotal role in diagnostic services, treatment delivery, and patient education on skin self-examination, offering additional value-added care to patients. However, further rigorous research is required to comprehensively evaluate these models.

While patient satisfaction with nurse-led care is generally high, ambiguity surrounding role definitions remains a significant barrier to fully realising its potential. This highlights the urgent need for standardised, scalable, and adaptable models tailored to local healthcare systems. Standardisation would enable nurse-led care to support dermatologists in addressing high referral demands while ensuring the delivery of consistent and equitable care globally. Additionally, robust, trial-based

evaluations are critical to assess resource efficiency, cost-effectiveness, and the overall contribution of nurse-led care to patient outcomes.

What is Already Known

- The role of nurses specialising in skin cancer varies widely, indicating diverse nurse-led models across different global contexts.
- The scarcity of comprehensive analyses on the effectiveness, efficiency, and patient outcomes associated with nurse-led models for managing skin cancer.
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What This Paper Adds

- Although no studies directly compared nurse-led care to dermatologist-led care, several studies demonstrated nurses' diagnostic accuracy in addition to their proficiency at identifying previously unsuspected lesions.
- Various nurse-led models have been identified as valuable in supporting physicians across different elements of the skin cancer care pathway.
- Advocating for and standardising nurse-led models in skin cancer care is crucial, enabling services to scale, adapt, and tailor these models to support dermatologists in managing high referral demands, while maintaining a consistent standard of care internationally.
- Rigorously designed studies are needed to further evaluate the resource efficiency, cost-effectiveness, and additional value-added care provided by nurse-led models.

Policy and Practice Implications

- **Training and Competency Development:** Completing nationally recognised dermatology nursing qualifications beyond the Advanced Clinical Practice pathway and practical training to extend assessment, diagnostic, and treatment skills are essential for autonomous practice in dermatology. Specific skills in nurse-led skin cancer care are vital to ensure clinical competency.

- **Dermatology Nurse Consultant Training Programme:** Policies should prioritise nationally recognised Advanced Nurse Practitioner to Dermatology Nurse Consultant Training Programmes focusing on assessment, diagnostic, and treatment skills. A structured, portfolio-based approach to training is crucial for achieving competency and enabling autonomous practice in dermatology, supporting the delivery of high-quality care.
- **Support for Community-Based Care:** Policy-level support for community-based care is critical, particularly in rural or underserved regions. These models reduce patient travel, improve timely care access, and provide training opportunities for rural clinicians, offering a viable alternative to hospital-based services.
- **Standardising Nurse-Led Models:** Developing national or international guidelines is essential for scaling nurse-led models. Standardisation allows these models to adapt to the specific needs of local services while maintaining high standards of care.
- **Delivering Comprehensive Care:** Nurse-led models show promise in delivering standard care comparable to physician-led services for specific components of the skin cancer care pathway. They also provide value-added care benefits, such as tailored patient education, enhancing outcomes and satisfaction.