Section: Miscellaneous

Systematic Review

RADIATION DERMATITIS IN BREAST CANCER PATIENTS: A SYSTEMATIC REVIEW

Chayan Roy[1], Deepak Kumar Sahu[2], Sudipta Chakraborty[3], Pradyut Saha[4]

[1]Medical Officer, Nishiganj Rural Hospital, Cooch Behar, West Bengal – 736157, India.
[2]Consultant, Department of Dermatology, Uttarbanga Clinic, Cooch Behar, West Bengal 736101, India.
[3]Medical officer, Department of Radiotherapy, Jalpaiguri Medical College and Hospital, Jalpaiguri, West Bengal 735101, India.
[4]Assistant Professor, Department of Radiotherapy, Siliguri, District Darjeeling, West Bengal - 734012, India.

Received : *26/04/2026*
Received in revised form : *09/06/2026*
Accepted : *25/06/2026*

Keywords:
Breast neoplasm, radiodermatitis, ionizing radiation toxicity, cutaneous adverse effects, evidence synthesis.

Corresponding Author:
Dr. Chayan Roy,
Email: chayan39.nrs@gmail.com

DOI: 10.47009/jamp.2026.8.4.12

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 63-70

ABSTRACT

Background: Among women worldwide, breast carcinoma holds the distinction of being the most prevalent malignant neoplasm diagnosed annually. Ionizing radiation delivered to the breast region forms an indispensable component of its multidisciplinary management approach. While the oncological merits of radiotherapy are thoroughly established, skin-related toxicity broadly categorized as radiation dermatitis emerges with notable regularity during and after the treatment course. This inflammatory cutaneous reaction carries a substantial burden for affected individuals, potentially disrupting their day-to-day activities, impairing psychological well-being, and undermining adherence to the planned therapeutic schedule. Clinically, the condition manifests across a wide spectrum, from mild surface reddening and superficial dryness to painful blistering and tissue breakdown in severe cases. **Objective:** This structured review was undertaken to consolidate and critically appraise published data on the frequency of occurrence, predisposing patient and treatment variables, prophylactic measures, and therapeutic interventions pertaining to radiation-associated skin injury in women undergoing breast radiotherapy. **Materials and Methods:** A methodical interrogation of four major biomedical databases, PubMed, Scopus, Web of Science, and the Cochrane Library, was performed. The temporal scope of the search extended from January 2015 through March 2025. Study designs deemed eligible for inclusion spanned randomized controlled trials, prospective observational cohorts, and prospective non-randomized designs, provided they recruited women with confirmed breast cancer receiving radiotherapy. Extracted information encompassed study-level characteristics, dermatitis frequency estimates, identified risk contributors, and comparative data on preventive and management approaches. **Results:** Fifteen qualifying studies collectively enrolling 4,325 participants met predefined eligibility standards and formed the analytic corpus. Dermatitis occurrence was documented across a span of 65% to 95% among treated patients, with milder Grade 1 and Grade 2 manifestations predominating. Elevated body mass index, substantial breast tissue volume, active tobacco smoking, the presence of diabetes mellitus, and concurrent administration of systemic chemotherapy were identified with the greatest consistency as factors magnifying dermatitis risk. Among preventive and management modalities assessed, topical corticosteroids delivered the most reproducible reductions in dermatitis severity. Barrier film formulations, silicone wound coverings, and emollient-based moisturizers additionally demonstrated clinically meaningful protective properties. **Conclusion:** Radiation-associated skin inflammation during breast cancer treatment carries a significant clinical burden that warrants proactive attention. Timely identification of patients harboring an elevated risk profile, combined with early deployment of evidence-grounded skin care protocols, offers a viable pathway toward reduced dermatitis severity and improved treatment tolerance. Establishing universally accepted management guidelines through sufficiently powered clinical investigation remains an unfulfilled priority in radiation oncology.

INTRODUCTION

Breast cancer occupies a singularly prominent position in global oncology statistics. It accounts for more newly diagnosed malignant cases among women than any other cancer type, and its associated morbidity and mortality place it at the forefront of public health priorities across high-income and low-income countries alike. Epidemiological surveillance data compiled over successive years consistently show that absolute case numbers remain on an upward trajectory, even as survival outcomes have improved through advances in early detection and multimodal therapy.[1] Among the treatment modalities credited with improving locoregional control, adjuvant external beam radiotherapy occupies a central role. It is routinely prescribed following breast-conserving surgery to eradicate residual microscopic disease, and is selectively employed after mastectomy in patients whose tumor characteristics place them at heightened risk of locoregional relapse. Well-powered randomized trials and subsequent meta-analyses have confirmed that the inclusion of adjuvant radiation meaningfully curtails the probability of local recurrence and translates into measurable improvements in overall survival.[2]

Despite these well-characterized therapeutic benefits, radiotherapy exposes non-target tissues, most immediately the skin overlying the treatment field, to cumulative doses of ionizing radiation sufficient to induce varying degrees of inflammatory injury. Acute radiation dermatitis, defined as an inflammatory skin reaction occurring during or shortly after the radiation course, is the single most commonly encountered cutaneous complication of breast irradiation. Its clinical expression ranges from transient erythema, surface dryness, and pruritus at milder severities, to frank moist desquamation, painful open erosions, and, in extreme cases, tissue ulceration or necrosis.[2,3] Beyond the physical discomfort these changes produce, radiation dermatitis can distress patients psychologically, reduce their capacity for self-care and normal daily activity, and, when sufficiently severe, necessitate unplanned interruptions or dose modifications that may compromise intended treatment delivery.

A heterogeneous array of factors, both patient-related and treatment-related, have been implicated in modulating individual susceptibility to radiation dermatitis. On the patient side, obesity, large breast dimensions, a history of cigarette smoking, advancing age, and comorbid glycemic dysregulation have emerged as particularly robust predictors of skin toxicity risk.[9,10] From a treatment perspective, parameters such as cumulative radiation dose, the fractionation scheme employed, technical delivery method, and whether cytotoxic chemotherapy is administered concurrently each contribute to the magnitude of skin injury ultimately observed.[2,9] Recognition of this multifactorial etiology has catalyzed growing investigative interest in identifying actionable risk indicators and designing preventive strategies accordingly.

Efforts to identify effective skin care interventions have generated a substantial body of trial evidence, with studied agents including steroid-based topical preparations, emollient creams, film-forming barrier products, and silicone-impregnated wound dressings.[5,6] However, this body of evidence is characterized by inconsistency in outcomes reporting, variability in study design, and divergent conclusions, making it difficult for clinicians to extract consensus-level guidance. In the absence of standardized prevention and management algorithms, considerable practice variation persists across radiation oncology settings.[11,12] It was against this backdrop that the current systematic review was conceived, with the intent of drawing together available evidence into a coherent synthesis addressing dermatitis incidence, predisposing risk variables, and the relative effectiveness of preventive and therapeutic interventions among breast cancer patients treated with radiotherapy.

The clinical question guiding this review was framed using the PICO construct. The target Population consisted of adult women with histologically confirmed breast cancer undergoing external beam radiotherapy; the Interventions of interest encompassed prophylactic and therapeutic skin care measures including corticosteroid-based topicals, barrier film applications, silicone dressings, and moisturizing preparations; the Comparators included standard institutional skin care protocols and alternative active interventions where applicable; and the Outcomes of primary relevance were the incidence, grade-specific severity, and effective management of radiation dermatitis. This structural framework guided all phases of the review from question formulation through evidence synthesis.

MATERIALS AND METHODS

The present review was designed to systematically appraise clinical evidence pertaining to acute skin toxicity arising from radiotherapy in breast cancer patients. All procedural aspects were conducted and reported in alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, which provides guidance on transparent, reproducible methodology for evidence synthesis.

Search Strategy

Literature retrieval was carried out across four established biomedical databases: PubMed, Scopus, Web of Science, and the Cochrane Library. The search was bounded temporally to records published no earlier than January 2015, with the final search date of 31 March 2025 marking the retrieval cutoff. Search strings were constructed using a combination of controlled vocabulary terms drawn from the Medical Subject Headings (MeSH) taxonomy and

ISSN (O): 2687-5365; ISSN (P): 2753-6556

free-text keyword phrases relevant to the intersection of breast malignancy and radiation-related skin complications. Terms deployed included: "breast cancer," "breast carcinoma," "radiotherapy," "radiation therapy," "radiation dermatitis," "radiodermatitis," "radiation-induced skin toxicity," "acute skin reactions," and "acute radiation dermatitis." Boolean logic connectors AND and OR were applied to broaden or narrow retrieval sets as needed. Following automated database querying, reference lists of all papers meeting eligibility requirements were manually examined to capture potentially relevant articles not surfaced through the automated strategy.

PRISMA Flow Diagram

Study selection proceeded in a sequential, two-tiered fashion consistent with PRISMA methodology. Following deduplication of records retrieved across databases, initial screening was conducted at the title and abstract level to eliminate clearly irrelevant records. Studies surviving this preliminary screen advanced to full-text review, at which point each article was assessed in detail against all prespecified eligibility requirements. Only studies fulfilling the full set of inclusion criteria without triggering any exclusion criterion were admitted into the final analytic corpus. Figure 1 presents the PRISMA flow diagram depicting the staged selection process.

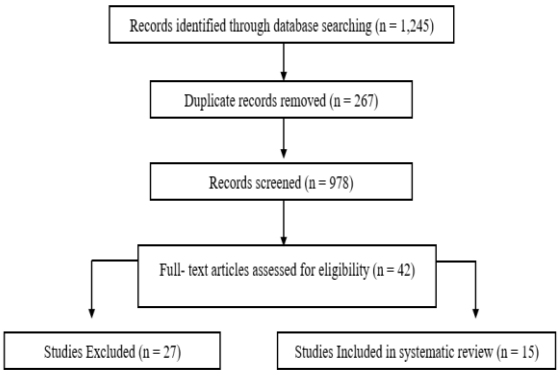

Figure 1: PRISMA Flow Chart Study Identification and Screening Process

Eligibility Criteria

Eligibility determinations were made against criteria formalized prior to initiating the literature search.

Inclusion Criteria

1. Investigations enrolling adult individuals carrying a confirmed histopathological diagnosis of breast cancer.
2. Studies wherein participants received radiotherapy as a formally incorporated element of their breast cancer treatment plan.
3. Studies that documented at least one of the following endpoints: dermatitis occurrence rates, graded severity assessments, predisposing risk characteristics, preventive intervention evaluation, or treatment response data.
4. Original research employing randomized controlled designs, prospective cohort methodologies, or prospective observational frameworks.
5. Articles published in the English language within the defined temporal window (January 2015–March 2025).
6. Studies containing sufficient quantitative or descriptive data to support extraction and analysis.

Exclusion Criteria

1. Case reports, case series, narrative reviews, opinion pieces, editorial commentaries, and letters.
2. Conference abstracts lacking an associated full-text peer-reviewed publication.
3. Studies conducted exclusively in patient populations with non-breast primary malignancies.
4. Pre-clinical or translational research, including in vitro investigations and animal model experiments.
5. Studies that did not report outcomes directly relevant to radiation-induced skin injury.
6. Duplicate reports from the same study population and records with data insufficient for reliable outcome interpretation.

Study Selection

Records from all databases were pooled into a reference management platform, and automated deduplication procedures were applied. Retained records then underwent two sequential rounds of screening. During the initial screen, titles and abstracts were reviewed to remove clearly non-eligible entries. Records not eliminated at this stage advanced to full-text review, where the complete article was examined against each eligibility criterion. Studies clearing the full-text review without triggering any exclusion criterion were entered into the final analytic pool. Disagreements arising during eligibility deliberations were resolved through discussion and collaborative re-examination of the source material.

Data Extraction

A structured data extraction template, developed specifically for this review, was used to standardize the capture of relevant study-level and outcome-level information. For each incorporated study, extracted variables encompassed: lead author identity, publication year, country of study conduct, study design, total enrollment, demographic profile of participants, radiotherapy delivery parameters (including fractionation schedules and cumulative doses), dermatitis grading system employed, dermatitis occurrence rates, identified risk determinants, preventive and management strategies evaluated, and principal study conclusions. Where reported, supplementary data pertaining to treatment-related delays, patient-reported outcomes, and quality-of-life measures were also extracted.

Quality Assessment

Methodological rigor was independently appraised for each included study using validated quality assessment tools matched to study design.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Randomized controlled trials were evaluated using the Cochrane Risk of Bias Tool, a structured instrument examining six key domains: random sequence generation, allocation concealment, blinding of participants and assessors, completeness of outcome data, freedom from selective reporting, and other potential sources of bias. Prospective observational and cohort studies were assessed using the Newcastle-Ottawa Scale, which appraises study quality across three domains: appropriateness of case selection, between-group comparability, and methodological soundness of outcome ascertainment. Each study was ultimately categorized as carrying low, moderate, or high risk of bias.

Outcome Measures

Dermatitis incidence and its grade-specific distribution constituted the primary outcome of interest. Secondary outcomes encompassed: the identification of patient demographic and clinical attributes that increase susceptibility to radiation skin toxicity; characterization of treatment-related parameters that modulate dermatitis risk; and evaluation of the comparative effectiveness of preventive and therapeutic interventions. Grading of dermatitis severity was referenced to two widely adopted classification systems: the Radiation Therapy Oncology Group (RTOG) toxicity scale and the Common Terminology Criteria for Adverse Events (CTCAE).

Data Synthesis

The degree of heterogeneity across included studies, stemming from variability in study design, patient demographics, radiation delivery protocols, intervention types, and grading instruments, rendered formal quantitative meta-analysis methodologically inappropriate. Evidence was therefore synthesized using a structured narrative approach. Findings were organized thematically to address the principal domains of dermatitis incidence, associated risk factors, preventive strategies, and management outcomes. Summary information from included studies was tabulated to facilitate comparative interpretation. The cumulative participant count was derived by summing enrollment figures across all fifteen studies.

Ethical Considerations

This systematic review drew entirely from previously published peer-reviewed research and did not involve any direct engagement with human participants, collection of personal identifiable health information, or experimental procedures. Under these circumstances, institutional ethical committee review was not applicable. The review was conducted in full observance of accepted standards governing secondary research.

RESULTS

Study Selection

The combined database query produced an initial retrieval of 1,245 records. Application of deduplication procedures eliminated 267 duplicate entries, leaving 978 unique records for title and abstract screening. Of these, 936 were judged insufficiently relevant at the preliminary screen and were excluded. The remaining 42 records were advanced to full-text review. Following comprehensive evaluation against all eligibility criteria, 27 records were excluded for the following reasons: failure to meet the patient population specification (n = 9), absence of dermatitis-specific outcome data (n = 8), reliance on review or abstract-only formats (n = 6), and inclusion of non-breast malignancy populations (n = 4). Ultimately, 15 studies satisfied all prespecified inclusion requirements and were admitted into the evidence synthesis.

Table 1: Summary of Study Selection at Each Screening Stage

Selection Stage	Number of Records
Initial records retrieved from databases	1,245
Duplicate records eliminated	267
Records remaining for title/abstract screening	978
Full-text articles evaluated for eligibility	42
Articles excluded at full-text stage	27
Studies incorporated into the review	15

Characteristics of Included Studies

The 15 incorporated studies enrolled a total of 4,325 breast cancer patients. Study designs encompassed randomized controlled trials, prospective cohort investigations, and observational prospective studies. Research was conducted across multiple geographic settings, including the United States, United Kingdom, India, China, Spain, and South Korea, lending geographic diversity to the pooled evidence base. Collectively, these investigations addressed dermatitis incidence and severity grading, explored patient-level and treatment-level risk determinants, and assessed the clinical utility of various preventive and therapeutic modalities. Table 2 presents a condensed overview of the pooled characteristics and key findings.

Table 2: Overview of Key Characteristics and Aggregate Findings Across Included Studies

Parameter	Findings
Total enrolled studies	15
Combined participant count	4,325

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Study designs represented	Randomized Controlled Trials; Prospective Cohort Studies; Prospective Observational Studies
Countries of origin	USA, UK, India, China, Spain, South Korea
Dermatitis incidence range	65% to 95%
Predominant severity grades	Grade 1 and Grade 2
Most frequently identified risk factors	Elevated BMI; Enlarged breast volume; Tobacco smoking; Diabetes mellitus; Concurrent chemotherapy
Effective prophylactic/therapeutic agents	Topical corticosteroids; Barrier film products; Silicone wound dressings; Emollient moisturizers
Overall clinical outcomes	Skin toxicity reduction; Improved patient comfort; Enhanced treatment schedule adherence

Incidence and Severity of Radiation Dermatitis

Across all 15 studies comprising the analytic sample, radiation-associated skin inflammation was identified as the most consistently documented cutaneous complication of breast irradiation. Reported occurrence rates demonstrated wide variability between studies, spanning a lower boundary of approximately 65% to an upper limit approaching 95% of treated patients. This variability likely reflects genuine heterogeneity in patient populations, fractionation protocols, and institutional skin care practices, in addition to differences in how dermatitis was operationally defined and graded across studies. Grade 1 presentations, characterized by mild erythema, superficial dryness, and intermittent pruritus, were most commonly observed. Grade 2 reactions, involving more pronounced erythema and patchy dry or early moist desquamation, constituted the second most frequently encountered severity level.

Grade 3 dermatitis, defined by the presence of confluent moist desquamation and significant symptomatic burden, was documented at substantially lower frequencies and tended to manifest in patients carrying multiple concurrent risk factors. Grade 4 reactions, which involve skin ulceration or frank necrosis and are associated with treatment-threatening toxicity, were rare occurrences and were principally confined to patients receiving comparatively higher cumulative radiation doses. A consistent observation across nearly all included studies was that some quantifiable degree of skin reaction occurred in virtually every patient, whether during active treatment or during the early post-treatment recovery phase. Table 3 summarizes the defining clinical characteristics and observed frequency distribution of each severity grade.

Table 3: Clinical Characteristics and Observed Frequency of Each Radiation Dermatitis Grade

Severity Grade	Defining Clinical Features	Observed Frequency
Grade 1	Faint erythema, dry skin, transient pruritus	Most common
Grade 2	Pronounced erythema, focal dry or early moist scaling	Common
Grade 3	Confluent moist desquamation, marked discomfort	Less common
Grade 4	Skin ulceration or tissue necrosis	Rare

Risk Factors Associated with Radiation Dermatitis

Multiple studies within the analytic corpus specifically examined clinical and demographic attributes that predispose patients to radiation skin injury, yielding a consistent set of risk-associated variables. Elevated body mass index was identified most frequently, surfacing as a significant predictor in ten of the fifteen studies. Mechanistically, the propensity for skin-on-skin contact in the inframammary and axillary folds, together with enhanced moisture retention in these regions, creates conditions that amplify the baseline tissue-damaging effects of radiation. This population also experiences inequitable dose distribution across the breast tissue surface, compounding their vulnerability.

Large breast tissue volume was the second most consistently cited risk attribute, reported in eight studies as an independent contributor to elevated dermatitis rates. The mechanistic rationale centers on the greater total irradiated skin surface area, the dosimetric inhomogeneity inherent in treating large tissue volumes, and the increased likelihood of skin folds receiving disproportionate dose. Active tobacco smoking, identified as a significant predictor in seven studies, is thought to heighten dermatitis susceptibility through its well-characterized deleterious effects on microvascular integrity and tissue oxygenation, which impair the skin's capacity for radiation-induced damage repair. Concurrent systemic chemotherapy administration was flagged as a clinically meaningful contributor in six studies, likely due to additive or synergistic mechanisms that sensitize epithelial tissues to radiation injury. Diabetes mellitus, documented in five studies, appears to operate through pathways involving microvascular dysfunction and compromised cellular repair kinetics. Older patient age was also identified, albeit with lower frequency, as a contributing risk factor. Table 4 provides a comparative summary of risk factor prevalence across the included studies.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 4: Identified Risk Factors and Their Prevalence Across Included Studies

Risk Factor	Number of Studies Reporting
Elevated body mass index	10
Large breast tissue volume	8
Active tobacco smoking	7
Concurrent systemic chemotherapy	6
Diabetes mellitus	5
Advancing patient age	4

Preventive and Management Strategies

A range of prophylactic and therapeutic interventions were evaluated across the included literature, with topical corticosteroid preparations demonstrating the most robust and reproducible evidence base. Studies employing these agents as part of structured skin care regimens documented markedly lower rates of moderate-to-severe (Grade 2 and Grade 3) dermatitis compared with standard care controls or alternative comparison arms. The mechanistic basis for this benefit lies in the anti-inflammatory pharmacological profile of corticosteroids, which attenuate the radiation-triggered cytokine cascade and reduce erythema and tissue edema. Barrier film products, designed to form a transparent, breathable, protective coating over the irradiated skin surface, were evaluated in four studies and produced encouraging results. Their primary mechanism of action involves limiting friction-induced epidermal trauma and reducing exposure to environmental irritants during the vulnerable treatment period. Silicone-based wound dressings, investigated across three studies, similarly demonstrated protective properties attributable to their capacity to maintain a moist wound healing environment and shield fragile irradiated tissue from mechanical trauma. Emollient moisturizers, assessed in five studies, reliably improved subjective skin hydration and patient-reported comfort, although their capacity to prevent escalation to severe dermatitis grades was less consistent, suggesting that their primary benefit may lie in symptom management rather than toxicity prevention. Evidence supporting other topical or complementary agents remained insufficient to draw reliable conclusions regarding their routine utility. Table 5 summarizes the intervention-level evidence.

Table 5: Evidence Summary for Prophylactic and Therapeutic Interventions

Intervention	Studies Evaluated	Evidence Strength
Topical corticosteroids	6	High
Barrier film products	4	High
Silicone-based wound dressings	3	Moderate to High
Emollient moisturizers	5	Moderate

Considered collectively, the aggregate data from these 15 studies affirm that radiation dermatitis is a highly prevalent and clinically meaningful complication of breast irradiation, arising through an interaction between individual patient characteristics and treatment-specific parameters. The assembled evidence strongly favors the preferential use of topical corticosteroids, barrier films, and silicone dressings as core elements of an evidence-informed skin care strategy directed at minimizing toxicity burden and preserving patient quality of life throughout the radiation course.

Clinical Implications

The findings of this review carry direct practical relevance for radiation oncology teams. Systematic pre-treatment risk stratification, targeting modifiable and non-modifiable risk determinants including BMI, breast volume, smoking status, diabetic history, and concurrent chemotherapy use, enables clinicians to identify patients most likely to experience significant dermatitis prior to commencing radiation. Early initiation of prophylactic skin care protocols in these high-risk individuals, with particular emphasis on topical corticosteroid application and barrier protection, represents a clinically sound strategy for mitigating expected toxicity. Concurrent structured patient education initiatives, covering proper wound hygiene, appropriate clothing choices, sun avoidance, and timely symptom reporting, should be systematically embedded within oncology care pathways to maximize early intervention opportunities and improve overall treatment adherence.

DISCUSSION

This systematic review synthesized clinical evidence from 15 published investigations to characterize the incidence, determinants, and management landscape of radiation-associated skin toxicity within the specific clinical context of breast cancer radiotherapy. The central finding, that dermatitis occurrence rates spanning 65% to 95% were observed across a broad and geographically diverse patient population, aligns with prior evidence identifying cutaneous radiation toxicity as one of the most predictable and burdensome sequelae of breast irradiation. The preponderance of milder-grade reactions in the included studies offers some reassurance; however, even Grade 1 and Grade 2 dermatitis can meaningfully degrade patient comfort, impair sleep and daily function, and erode adherence to the prescribed radiation schedule.[2,3]

The biological rationale underlying the high frequency of radiation dermatitis is well established. Ionizing radiation exerts direct cytotoxic effects on

ISSN (O): 2687-5365; ISSN (P): 2753-6556

proliferating basal keratinocytes in the basal layer of the epidermis while simultaneously triggering an inflammatory cascade involving the release of pro-inflammatory cytokines and reactive oxygen species within the dermis.[1] As cumulative radiation dose accumulates over the fractionated treatment course, erythema and surface dryness typically emerge early, with more severe manifestations such as confluent moist desquamation developing at later time points, particularly in patients whose baseline skin repair capacity is already compromised. The accompanying physical manifestations, pain, burning sensation, pruritus, and cosmetic changes, cumulatively diminish the subjective treatment experience of patients who are already managing the psychological and physical demands of cancer care.

The risk factor profile identified in this review closely mirrors findings from earlier syntheses and single-center studies. Elevated BMI emerged as the most robustly replicated predisposing variable, consistent with known mechanisms by which excess adipose tissue promotes inframammary and axillary skin fold apposition, creating microenvironments characterized by sustained friction and moisture accumulation that augment intrinsic radiation damage.[9,10] Large breast tissue volume parallels BMI as a risk determinant through distinct but complementary mechanisms, specifically, the greater total surface area exposed to radiation and the dosimetric challenges inherent in achieving homogeneous dose distribution across large tissue volumes. Critically, both of these risk factors are measurable and documentable at baseline, rendering them actionable targets for individualized risk stratification prior to commencing treatment.

Tobacco smoking, consistently flagged across multiple studies as a dermatitis risk contributor, impairs the tissue repair response through its well-documented adverse effects on microvascular perfusion and tissue oxygenation. Radiation-induced skin injury in smokers may therefore evolve more rapidly, reach greater severity, and resolve more slowly than in non-smoking counterparts. Diabetes mellitus exerts its dermatitis-potentiating effects through analogous mechanisms, with microvascular compromise and dysregulated cellular repair kinetics serving as the principal pathways through which glycemic dysregulation heightens cutaneous radiosensitivity. Concurrent chemotherapy, cited in six studies, may sensitize epithelial tissues to radiation injury through mechanisms involving direct cellular toxicity and potentiation of the radiation-triggered inflammatory cascade, yielding additive or synergistic elevations in overall cutaneous damage risk.

Among the therapeutic and preventive modalities assessed, topical corticosteroids generated the most consistent and clinically compelling evidence across the included studies. Their anti-inflammatory mechanism, principally the suppression of key pro-inflammatory cytokines and reduction of vascular permeability, appears well-suited to attenuating the radiation-induced inflammatory cascade that underlies dermatitis pathogenesis.[13,14] Barrier film formulations and silicone wound dressings demonstrated corroborating evidence of protective benefit, mechanistically grounded in their shared capacity to reduce frictional trauma to irradiated skin and modify the local wound microenvironment. Moisturizers improved subjective symptom experience reliably but showed less consistent evidence of preventing escalation to severe grades of dermatitis, suggesting their role may be primarily supportive rather than prophylactic.

From a broader clinical implementation standpoint, the evidence from this review supports a shift toward individually tailored, risk-informed approaches to radiation skin care. The availability of measurable baseline risk predictors, BMI, breast dimensions, smoking history, diabetes status, chemotherapy schedule, equips clinicians with actionable information for stratifying patients prior to treatment and initiating prophylactic measures in those at greatest risk. Structured patient education should be viewed as an integral component of supportive care, empowering patients with practical knowledge of skin care practices, warning signs requiring early medical attention, and the importance of treatment adherence.

This review recognizes several methodological constraints that merit transparent acknowledgment. Study heterogeneity was substantial across included investigations, spanning design types, patient demographics, fractionation approaches, and dermatitis grading instruments. This diversity precluded formal meta-analytic pooling and limits the precision of cross-study comparisons. Differential follow-up duration across studies may have influenced the completeness with which dermatitis events, particularly those occurring in the post-treatment period, were captured. The existence of publication bias cannot be dismissed; investigations reporting favorable or statistically significant outcomes are preferentially published, creating the potential for an optimistic skew in the apparent effectiveness estimates of preventive interventions. Restriction of the search to English-language publications may additionally have introduced a linguistic bias, with potentially relevant findings from studies published in other languages going unrepresented.

Advancing the evidence base in this field will require large-scale, multi-institutional randomized controlled trials designed with prospectively harmonized outcome measures, standardized grading instruments, and pre-specified follow-up timelines adequate to capture the full temporal trajectory of dermatitis events. Prospective evaluation of modern radiotherapy delivery technologies, including intensity-modulated radiation therapy, volumetric arc therapy, and proton-based approaches and their associated dermatologic toxicity profiles represents a particularly timely and clinically relevant research direction. Development of internationally endorsed,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

evidence-derived clinical practice guidelines addressing the prevention and management of radiation dermatitis in breast cancer patients remains an unfulfilled priority and an attainable goal within the current landscape.

Limitations

Several constraints in this review warrant explicit discussion. The included studies exhibited considerable heterogeneity in their design features, enrolled patient populations, radiation delivery parameters, choice of dermatitis grading instruments, and approaches to outcome documentation. This collective variation made it methodologically inappropriate to combine results quantitatively, which constrains the precision and generalizability of the synthesized conclusions.

The duration of post-treatment follow-up varied substantially across studies, potentially introducing differences in the completeness with which late-onset or protracted dermatitis events were ascertained. Longer or more standardized follow-up periods across future studies would yield more complete and comparable outcome datasets. Publication bias poses an additional limitation; clinical trials yielding positive or statistically significant results are over-represented in the published literature, and the apparent effectiveness of the preventive interventions catalogued in this review may therefore reflect a degree of optimistic inflation. Finally, the decision to restrict the eligible literature to English-language publications may have inadvertently excluded relevant findings from studies published in other languages, potentially limiting the geographic representativeness of the evidence base.

CONCLUSION

Radiation-associated skin toxicity is a clinically significant and near-universal complication of breast irradiation, characterized by wide inter-patient variability in severity driven by a constellation of patient-specific and treatment-related risk factors. This systematic review documents dermatitis occurrence rates ranging from 65% to 95% across a geographically diverse set of 15 studies, with milder presentations predominating and severe reactions largely confined to patients carrying multiple high-risk attributes. Elevated BMI, large breast volume, active smoking, concurrent chemotherapy, and diabetes mellitus emerged as the most reproducibly supported risk determinants. Among available preventive and management modalities, topical corticosteroids, barrier film formulations, and silicone wound dressings collectively demonstrated the strongest and most consistent evidence for reducing radiation-induced cutaneous injury. Systematic pre-treatment risk stratification, early prophylactic intervention, and structured patient education programs offer the most defensible framework for minimizing the dermatological burden of breast radiotherapy. Adequately powered multicenter trials employing standardized methodology are required to establish definitive evidence-based clinical practice guidelines and optimize supportive dermatologic care for this patient population.

REFERENCES

1. Singh M, Alavi A, Wong R, Akita S. Radiodermatitis: a review of our current understanding. Am J Clin Dermatol. 2016;17(3):277-292.
2. Kole AJ, Kole L, Moran MS. Acute radiation dermatitis in breast cancer patients: challenges and solutions. Breast Cancer (Dove Med Press). 2017;9:313-323.
3. Haruna F, Lipsett A, Marignol L. Topical management of acute radiation dermatitis in breast cancer patients: a systematic review and meta-analysis. Anticancer Res. 2017;37(10):5343-5353.
4. Miller RC, Schwartz DJ, Sloan JA, Griffin PC, Deming RL, Anders JC, et al. Mometasone furoate effect on acute skin toxicity in breast cancer patients receiving radiotherapy: a phase III double-blind, randomized trial. Int J Radiat Oncol Biol Phys. 2011;79(5):1460-1466.
5. Hindley A, Zain Z, Wood L, Whitehead A, Sanneh A, Barber D, et al. Mometasone furoate cream reduces acute radiation dermatitis in patients receiving breast radiation therapy: results of a randomized trial. Int J Radiat Oncol Biol Phys. 2014;90(4):748-755.
6. Ho AY, Olm-Shipman M, Zhang Z, Siu CT, Wilgucki M, Phung A, et al. A randomized trial of mometasone furoate 0.1% to reduce high-grade acute radiation dermatitis in breast cancer patients receiving postmastectomy radiation. Int J Radiat Oncol Biol Phys. 2018;101(2):325-333.
7. Ulff E, Maroti M, Serup J, Falkmer U. A potent steroid cream is superior to emollients in reducing acute radiation dermatitis in breast cancer patients treated with adjuvant radiotherapy. Radiother Oncol. 2013;108(2):287-292.
8. Shaw SZ, Nien HH, Wu CJ, Lui LT, Su JF, Lang CH. 3M Cavilon No-Sting Barrier Film versus topical corticosteroid for prevention of radiation dermatitis: a clinical trial. J Formos Med Assoc. 2015;114(5):407-414.
9. Cordoba EE, Lacunza E, Guerci AM. Clinical factors affecting the determination of radiotherapy-induced skin toxicity in breast cancer. Radiat Oncol J. 2021;39(4):315-323.
10. Dzul SP, Ninia J, Jang H, Kim S, Dominello MM. Predictors of acute radiation dermatitis in patients receiving whole-breast radiation therapy. Pract Radiat Oncol. 2022;12(1):52-59.
11. Behroozian T, Goldshtein D, Ryan Wolf J, van den Hurk C, Finkelstein S, Lam H, et al. MASCC clinical practice guidelines for the prevention and management of acute radiation dermatitis: Part 1. Systematic review. EClinicalMedicine. 2023;58:101886.
12. Kao YS, Wu YC, Wu MY, Wu PL, Lu LY, Hung CH, et al. Topical prevention of radiation dermatitis in breast cancer patients: a network meta-analysis of randomized controlled trials. In Vivo. 2023;37(3):1346-1357.
13. Liu W, Wang L, Meng D, Hong C, Zhang Q, Yang J. Effectiveness of topical corticosteroids on the prevention of acute radiation dermatitis in patients with breast cancer: an updated systematic review and meta-analysis. Asia Pac J Oncol Nurs. 2024;11(9):100553.
14. Kuszaj O, Day M, Tse SSW, Lee SF, Wang AJ, Bayrakdarian S, et al. A critical review of randomized controlled trials on topical corticosteroids for the prevention of radiation dermatitis in breast cancer. Support Care Cancer. 2025;33(2):147.

ISSN (O): 2687-5365; ISSN (P): 2753-6556