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Research trends and hot spots in the prevention and management of radiation dermatitis: a bibliometric analysis based on CiteSpace



Lu Zhang^{1†}, Lian Liu^{1†}, Fang Li^{2†}, Peijuan Chen¹ and Feng Ye^{1*}

Abstract

Objective This study sought to examine the current state and explore the key areas and emerging trends in radiation dermatitis prevention and management through bibliometric analysis, with the goal of providing valuable insights for future research endeavors.

Methods This study analyzed all publications on radiation dermatitis prevention and management from the Web of Science (WOS) core database up to 2024. The CiteSpace software was utilized to visualize authors, countries/regions, publishing institutions, keywords, co-cited documents, hot spots, and research frontiers.

Results A total of 459 articles (1995–2024) were identified, with the overall number of publications demonstrating an increasing trend. The United States (125) produced the highest number of publications, followed by China (73) and Canada (45). Key research topics encompass breast cancer, head and neck cancer, acute radiation dermatitis, and radiation recall dermatitis. Double-blind clinical trials constitute the primary research methodology. The main research areas in this field focus on the role of radiotherapy dose fractionation modalities, atmospheric pressure cold plasma, hyperbaric oxygen therapy (HBOT), aloe vera, biomodulation therapy, and biological dressings in the prevention and management of radiation dermatitis.

Conclusion This comprehensive bibliometric analysis reveals that risk prediction, assessment tools, and the efficacy of radiodermatitis are prominent research topics in the field. These areas are currently experiencing rapid growth and warrant further attention from researchers.

Keywords Radiation dermatitis, Prevention, Management, Bibliometrics, Visual analysis

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Introduction

The latest report from the International Agency for Research on Cancer (IARC) indicates that there were nearly 20 million new cancer cases and 9.7 million deaths worldwide in 2022, with projections suggesting new cases will increase to 35 million by 2050, representing a 77% rise from 2022 [1]. Radiation therapy (RT) is a primary clinical treatment for cancer patients, utilizing high-energy rays to directly and indirectly destroy tumor cells and tissues [2]. Approximately 50%-70% of all cancer patients undergo radiotherapy [3]. However, while radiotherapy targets tumors, it can also induce various adverse effects, including nausea, vomiting, radiation dermatitis, and bone marrow suppression [2, 4, 5]. Radiation dermatitis (RD) is among the most prevalent adverse reactions, with 95% of radiotherapy patients experiencing varying degrees of dermatitis during treatment [6]. Consequently, the prevention and management of RD are crucial components of cancer treatment and care.

RD can be classified into acute and chronic types based on the time of onset. Acute radiation dermatitis (ARD) manifests within 90 days post-radiotherapy, presenting symptoms ranging from mild (itching, pain, pigmentation) to severe (ulcers, bleeding, necrosis) [7]. Chronic radiation dermatitis (CRD) typically develops months or years after radiotherapy, characterized by skin atrophy, fibrosis, and pigmentation, with severe cases potentially leading to functional limitations and tissue contracture [6]. Research indicates that one-third of patients develop CRD at least a decade post-radiotherapy [8]. The prevention and management strategies for RD are diverse, with previous studies demonstrating the efficacy of creams, topical and internal medications, herbs, and dressings in reducing RD incidence or severity. However, the generalizability and consistency of some findings have diminished due to advancements in radiotherapy techniques and clinical research methodologies [9, 10]. Consequently, there is a need for a comprehensive scientific review of RD prevention and management strategies

Tabl	e 1	Search	strategy
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Set	Search query
#1	TS= ("Radiodermatitis" OR "Recall Reaction, Radia-
	tion" OR "Reaction, Radiation Recall" OR "Radiation
	Recall Reaction" OR "Dermatitis, Radiation Recall" OR
	"Dermatitides, Radiation Recall" OR "Radiation Recall
	Dermatitis" OR "Dermatitis, Radiation Induced"
	OR "Dermatitis, Radiation-Induced" OR "Radiation
	Induced Dermatitis" OR "Radiation-Induced Derma-
	titis" OR "radiation dermatitis" OR "treat radiation-
	induced skin reactions" OR "Radiation-Induced Skin
	Dermatitis" OR "radiation-induced skin reactions" OR
	"radiation-related dermatitis" OR "acute radiationin-
	duced skin reactions" OR "radiation skin injury")
#2	TS= ("prevention" OR "management" OR "treatment")
#3	#1 AND #2

to identify areas warranting further investigation and exploration.

CiteSpace is a bibliometric visualization software that analyzes the research foundation, current status, focal points, and emerging trends of specific fields [11]. It has been extensively utilized across various domains including informatics, management, technology, and clinical medicine [12–15]. Several researchers have conducted bibliometric analyses in tumor-related fields [16, 17]. However, the prevention and management of RD remains unaddressed. Through bibliometric analysis of literature from the past three decades, this study aims to elucidate the current state of research in the field of RD prevention and management, identify cutting-edge dynamics, and provide valuable insights for future research developments in this area.

Materials and methods Search strategy

This study utilized the Web of Science (WOS) Core Collection database for the literature review. The search encompassed the period from the database's inception to April 6, 2024. The search terms "radiation dermatitis," "prevention," "treatment," and "management" were applied to the topic field, with the detailed search strategy presented in Table 1. To mitigate potential bias from database updates, the literature retrieval was completed within a single day (April 6, 2024). Figure 1 illustrates the detailed flowchart of the process. Two researchers (LZ and FL) independently performed the initial screening of literature by reviewing titles and abstracts to assess thematic relevance.In cases of disagreement, a third author (LL) participated in discussions to determine literature inclusion.

Inclusion and exclusion criteria

Inclusion criteria: (1) Original articles and reviews focusing on the prevention, treatment, or management of RD; (2) Articles published in English;

Exclusion criteria: (1) conference abstracts, letters, editorials, errata, and similar non-peer-reviewed materials; (2) publications not written in English; (3) studies irrelevant to the research topic; (4) articles without full text availability; (5) publications lacking findings; (6) retracted articles; and (7) duplicate publications.

Research methods

This study employed CiteSpace software (version 6.3.R1) as the primary research tool. In constructing visual representations of knowledge graphs, we followed the main procedural phases outlined by CiteSpace, which include time slicing, thresholding, modeling, pruning, merging, and mapping [18]. The time partition length was set to 1, and the threshold TOP was 50. The analysis encompassed



Fig. 1 Flowchart of literature search, screening and analysis

authors, institutions, countries/regions, keywords, and co-cited articles in the field of RD prevention and management. Furthermore, we utilized key CiteSpace concepts, such as burst detection, betweenness centrality, and heterogeneous networks. These concepts enable the timely visualization of research status, hot spots, and frontiers [19]. For result reporting and discussion, we adhered to the '5W1H' principle, which comprises What, Where, When, Who, Why, and How [20].

Results

Temporal distribution map of the literature

After excluding 564 ineligible papers, 459 publications were ultimately selected for analysis. Figure 2 illustrates the annual publication output on the prevention and

management of RD and the field's trend from 1995 to 2024, demonstrating an overall upward trajectory. Due to the search cutoff date of April 6, 2024, the number of publications in 2024 represented only approximately one-quarter of the average. An exponential growth model was employed to assess the relationship between annual publications and the year of publication. The model fitting the growth trend of annual publications ($R^2 = 0.8012$) suggested a sustained increase in research on the prevention and management of RD.

Authors

Each node in the visualization represents an author, with the node size indicating the number of publications and the line thickness representing the strength of





Fig. 2 Annual publications on radiation dermatitis prevention and management



Fig. 3 Cooperation of different authors focusing on radiation dermatitis

collaboration between authors. Figure 3 illustrates that a total of 760 authors contributed to research on the prevention and management of RD, with 1794 connections among them. The two authors with the highest number of publications are both from Canada: Edward Chow from the University of Toronto and Tara Behroozian from McMaster University. These researchers demonstrate a strong collaborative relationship. Table 2 presents a list of the top 11 authors in this field.

Institutions

As illustrated in Fig. 4, the knowledge graph of the institutional cooperation network encompasses 399 institutions and 630 cooperative links. The five institutions with the highest publication output are: University of Toronto, McMaster University, Sunnybrook Research Institute, University of Rochester, and Azienda Ospedaliero Universitaria Careggi. The top three institutions are all located in Canada, while the top nine institutions are

 Table 2
 Cooperation of different authors focusing on radiation dermatitis

Rank	Author	Count	Year
1	Chow, Edward	18	2020
2	Behroozian, Tara	17	2022
3	Bonomo, Pierluigi	14	2017
4	Wolf, Julie Ryan	12	2023
5	van den hurk, Corina	12	2023
6	Caini, Saverio	12	2017
7	Robijns, Jolien	9	2021
8	Bulens, Paul	9	2014
9	Bensadoun, Rene-Jean	7	2012
10	Lam, Henry	7	2023
11	Claes, Stefan	7	2014

from Europe and the United States (USA), as detailed in Table 3.

Countries/regions

Figure 5 depicts the National Cooperation Network Knowledge Map, encompassing 48 countries/regions and 116 cooperation links, with a network density of 0.1028. As illustrated in Fig. 5; Table 4, the United States, China, and Canada rank among the top countries in terms of research output. The United States demonstrates leadership in both publication volume and centrality.

Co-cited references and references bursts

Document co-citation analysis using CiteSpace revealed 754 nodes, 2225 links, and a density of 0.0078 (Fig. 6). Table 5 presents the top 10 cited publications. The most frequently cited article, "Management of acute radiation dermatitis: A review of the literature and proposal for treatment algorithm," published in 2019, received 36 citations. It was followed by "Acute radiation dermatitis in breast cancer patients: challenges and solutions"

Table 3 Top 10 institutions in the field of radiation dermatitis

 prevention and management

Rank	Institution	Count	Year	Centrality
1	University of Toronto	24	2008	0.03
2	McMaster University	19	2006	0.13
3	Sunnybrook Research Instituter*	18	2008	0.03
4	University of Rochester	17	2012	0.1
5	Azienda Ospedaliero Universi- taria Careggi	16	2017	0.06
6	Hasselt University	14	2014	0.04
7	University of Florence	13	2023	0.06
8	UNICANCER	7	2004	0.03
9	Mayo Clinic	7	1996	0.01
10	Chang Gung Memorial Hospital	7	2010	0

*Sunnybrook Health Sciences Centre and Sunnybrook Research Institute share the same code

with 31 citations and "Radiodermatitis: A Review of Our Current Understanding" with 27 citations. Among these articles, "A single-blind, randomized controlled trial of StrataXRT[®] - A silicone-based film-forming gel dressing for prophylaxis and management of radiation dermatitis in patients with head" exhibited the highest centrality (0.18).

The 25 most influential references, as indicated by their strong citation burst, are depicted in Fig. 7. The reference exhibiting the strongest citation burst is "Radiodermatitis: A Review of Our Current Understanding" (Strength: 10.55), published in 2016.

Research hotspots and frontier analysis *Research hotspots*

In addition to the primary keywords like radiotherapy, RD, prevention, management, and treatment, other frequently occurring terms include "breast cancer," "double-blind," "acute radiation dermatitis," "phase III," and



Fig. 4 Knoswledge graph of literature institution cooperation network



CiteSpace

Fig. 5 The cooperation of countries/regions in the field of radiation dermatitis prevention and management

Table 4Top 10 countries/regions with the most publications onradiation dermatitis prevention and management

Rank	Country	Count	Year	Centrality
1	USA	125	1996	0.44
2	China	73	2010	0.12
3	Canada	45	2004	0.13
4	Italy	37	2005	0.05
5	Germany	35	2001	0.01
6	Brazil	31	2008	0.01
7	France	27	2004	0.12
8	Japan	27	2009	0.07
9	Netherlands	23	2008	0.11
10	Australia	22	2001	0.13

"cream." This suggests that research in the domain of RD prevention and management predominantly centers on breast cancer, clinical studies, ARD, and topical creams (see Fig. 8). Table 6 presents the top 10 keywords.

Keyword cluster analysis facilitates the examination of research focus and delineation of primary research content in specific fields. This study employed the "Keyword" and "LLR" algorithms for clustering. The data clustering yielded a Q value of 0.5162 and an S value of 0.814, resulting in 10 clusters: #0 double-blind, #1 head and neck, #2 oncology nursing, #3 radiation recall, #4 skin, #5 topical amitriptyline, #6 aloe vera, #7 photobiomodulation therapy, #8 acute radiation dermatitis, and #9 local application (see Fig. 9). Through further inductive analysis integrating high-frequency and high centrality keywords, the study identified the primary research areas in the prevention and management of RD: (1) Research subjects/ diseases: breast cancer, head and neck tumors, ARD, radiation recall dermatitis; (2) Research methodology: double-blind clinical trials; (3) Research focus: investigating the efficacy of radiotherapy dose-splitting modalities, atmospheric pressure cold plasma, hyperbaric oxygen therapy, aloe vera, biomodulation therapies, and biological dressings in preventing and managing RD, as detailed in Table 7.

Research frontiers

Burst words are keywords that appear frequently within a short timeframe, indicating the emergence, decline, or intensity of specific topics. These words aid in describing the evolution and development trends of research frontiers and predicting future research directions [11]. In the field of RD prevention and management, 22 burst keywords emerged. Figure 10 illustrates the initial appearance and duration of these keywords. The keyword with the strongest burst is "prophylactic agent" (strength = 6.42), followed by "head" (strength = 4.89) and "double-blind" (strength = 4.59). Analyzing the appearance times reveals that early burst keywords included radiation recall, Aloe vera gel, prophylactic agent, phase III, double-blind, Biafine, and breast radiation. The topic of "radiation recall" has attracted considerable attention over the past two decades, particularly from 1995 to 2014. Notably, 2004 marked a peak in the prevalence of keywords associated with this field, yielding six key terms: "prophylactic agent," "phase III," "double-blind," "Biafine," "oncology group rtog," and "breast irradiation." Currently, "risk factors" and "radiodermatitis" are at the forefront of research and in the burst period. Radiodermatitis primarily refers to the assessment tools and efficacy of RD.



Fig. 6 Knowledge network map of co-cited references

Rank	Author	Year	Cited references	Frequency	Centrality	IF (2022)	JCR	Journal
1	Rosenthal, A	2019	Management of acute radiation dermatitis: A review of the literature and proposal for treatment algorithm	36	0.01	13.7998	Q1	Journal of the American Academy of Dermatology
2	Kole AJ	2017	Acute radiation dermatitis in breast cancer patients: challenges and solutions	31	0.05	2.6002	Q4	Breast Cancer- targets and Therapy
3	Singh M	2016	Radiodermatitis: A Review of Our Current Understanding	27	0.03	7.3003	Q1	American Jour- nal of Clinical Dermatology
4	Ferreira, EB	2017	Topical interventions to prevent acute radiation dermati- tis in head and neck cancer patients: a systematic review	24	0.03	3.1000	Q3	Supportive Care in Cancer
5	Haruna, F	2017	Topical Management of Acute Radiation Dermatitis in Breast Cancer Patients: A Systematic Review and Meta-Analysis	23	0.02	1.9999	Q4	Anticancer Research
6	Finkelstein, S	2022	Comparison of clinical practice guidelines on radiation dermatitis: a narrative review	21	0.1	3.1000	Q3	Supportive Care in Cancer
7	Fuzissaki, MD	2019	The Impact of Radiodermatitis on Breast Cancer Patients' Quality of Life During Radiotherapy: A Prospective Cohort Study	20	0.01	4.7003	Q2	Journal of Pain and Symptom Management
8	Wooding, H	2018	The effect of Mepitel Film on acute radiation-induced skin reactions in head and neck cancer patients: a feasibility study	20	0.03	10.3005	Q1	British Journal of Dermatology
9	Ho, AY	2018	A Randomized Trial of Mometasone Furoate 0.1% to Reduce High-Grade Acute Radiation Dermatitis in Breast Cancer Patients Receiving Postmastectomy Radiation	20	0.06	6.9997	Q2	International Journal of Radia- tion Oncology Biology Physics
10	Chan, RJ	2019	A single-blind, randomized controlled trial of StrataXRT [®] - A silicone-based film-forming gel dressing for prophy- laxis and management of radiation dermatitis in patients with head and neck cancer	19	0.18	6.999	Q2	Radiotherapy and Oncology

Table 5 🛛	The top 10) most cited docui	nents on the preve	ention and manag	agement of radiation dermatitis
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Top 25 References with the Strongest Citation Bursts

References	Year St	rength Begin End	1995 - 2024
Bolderston A, 2006, SUPPORT CARE CANCER, V14, P802, DOI 10.1007/s00520-006-0063-4, DOI	2006	4.89 2007 2011	
Hymes SR, 2006, J AM ACAD DERMATOL, V54, P28, DOI 10.1016/j.jaad.2005.08.054, <u>DOI</u>	2006	5.22 2010 2011	
Pignol JP, 2008, J CLIN ONCOL, V26, P2085, DOI 10.1200/JCO.2007.15.2488, DOI	2008	4.41 2010 2012	
McQuestion Maurene, 2011, SEMIN ONCOL NURS, V27, Pe1, DOI 10.1016/j.soncn.2011.02.009, DOI	2011	7.17 2012 2016	
Salvo N, 2010, CURR ONCOL, V17, P94	2010	5.9 2012 2015	
Ryan JL, 2012, J INVEST DERMATOL, V132, P985, DOI 10.1038/jid.2011.411, DOI	2012	7.91 2013 2017	
Miller RC, 2011, INT J RADIAT ONCOL, V79, P1460, DOI 10.1016/j.ijrobp.2010.01.031, <u>DOI</u>	2011	7.46 2013 2016	
Chan RJ, 2012, INT J RADIAT ONCOL, V84, PE357, DOI 10.1016/j.ijrobp.2012.05.009, DOI	2012	6.32 2013 2017	
Kirova YM, 2011, RADIOTHER ONCOL, V100, P205, DOI 10.1016/j.radonc.2011.05.014, DOI	2011	5.72 2013 2016	
Wong RKS, 2013, SUPPORT CARE CANCER, V21, P2933, DOI 10.1007/s00520-013-1896-2, DOI	2013	9.18 2014 2018	
Sharp L, 2013, EUR J ONCOL NURS, V17, P429, DOI 10.1016/j.ejon.2012.11.003, DOI	2013	6.1 2014 2018	
Ulff E, 2013, RADIOTHER ONCOL, V108, P287, DOI 10.1016/j.radonc.2013.05.033, DOI	2013	6.48 2015 2018	
Chan RJ, 2014, BMC CANCER, V14, P0, DOI 10.1186/1471-2407-14-53, DOI	2014	9.19 2016 2019	
Herst PM, 2014, RADIOTHER ONCOL, V110, P137, DOI 10.1016/j.radonc.2014.01.005, DOI	2014	7.64 2016 2019	
Singh M, 2016, AM J CLIN DERMATOL, V17, P277, DOI 10.1007/s40257-016-0186-4, DOI	2016	10.55 2017 2021	
Bray FN, 2016, DERMATOLOGY THER, V6, P185, DOI 10.1007/s13555-016-0120-y, <u>DOI</u>	2016	6.21 2017 2021	
Hindley A, 2014, INT J RADIAT ONCOL, V90, P748, DOI 10.1016/j.ijrobp.2014.06.033, DOI	2014	5.48 2017 2019	
Ferreira EB, 2017, SUPPORT CARE CANCER, V25, P1001, DOI 10.1007/s00520-016-3521-7, DOI	2017	6.66 2018 2022	
Haruna F, 2017, ANTICANCER RES, V37, P5343, DOI 10.21873/anticanres.11960, DOI	2017	6.37 2018 2022	
Kole AJ, 2017, BREAST CANCER-TARGET, V9, P313, DOI 10.2147/BCTT.S109763, DOI	2017	9.97 2019 2022	
Hegedus F, 2017, INT J DERMATOL, V56, P909, DOI 10.1111/ijd.13371, <u>DOI</u>	2017	5.74 2019 2022	
Leventhal J, 2017, ONCOLOGY-NY, V31, P885	2017	4.93 2020 2022	
Wei JL, 2019, CANCER MANAG RES, V11, P167, DOI 10.2147/CMAR.S188655, <u>DOI</u>	2019	4.42 2020 2022	
Fuzissaki MD, 2019, J PAIN SYMPTOM MANAG, V58, P92, DOI 10.1016/j.jpainsymman.2019.03.017, DO	2019	4.8 2021 2024	
Rosenthal A, 2019, J AM ACAD DERMATOL, V81, P558, DOI 10.1016/j.jaad.2019.02.047, DOI	2019	7.27 2022 2024	

Fig. 7 Burst analysis of co-cited literature



Fig. 8 Keyword co-occurrence network knowledge graph

Discussion

The overall number of publications on RD prevention and management is limited but exhibits a fluctuating growth trend. Studies project an increase in new cancer cases [1], potentially leading to a rise in radiotherapy treatments and, consequently, more patients experiencing radiodermatitis. This underscores the ongoing importance of research in the prevention and management of radiodermatitis. An analysis of authors, institutions, and countries/regions contributing to the literature reveals that

 Table 6
 Top 10 keywords in radiation dermatitis prevention and management research

Rank	Keywords	Count	Centrality
1	breast cancer	149	0.15
2	double blind	90	0.05
3	acute radiation dermatitis	62	0.08
4	phase iii	58	0.02
5	cream	49	0.1
6	head	37	0.04
7	randomized trial	37	0.06
8	quality of life	35	0.03
9	trial	31	0.05
10	aloe vera gel	30	0.07

top-published authors Chow Edward and Behroozian Tara have established a close collaboration, conducting comprehensive systematic reviews and meta-analyses on RD prevention and management [21-24]. Furthermore, they jointly contributed to developing the Multinational Association for Supportive Care in Cancer (MASCC) clinical practice guidelines for the prevention and management of ARD [9]. Their work has made significant contributions to the field. Other authors have also formed collaborative networks of notable scope. High-volume publishing institutions are predominantly concentrated in Europe and the USA, with the USA leading in both publication volume and centrality. This prominence correlates with the USA's advanced economy, medical technology, and extensive international collaborations. Although China ranks second in total published articles, its low centrality suggests room for improvement in literature quality. To enhance research impact, increased investment in radiodermatitis prevention and management research and strengthened large-scale cooperation

with developed countries are recommended. After three decades of development, research on RD has evolved from empirical symptom management to a comprehensive, multimodal approach to precision prevention and control. Integrating the results of the bibliometric analysis, the development process of RD can be broadly categorized into three stages: an exploratory phase from 1995 to 2015, a breakthrough phase from 2016 to 2019, and an era of precise prevention and control beginning in 2020.

Early studies conducted between 1995 and 2015 primarily focused on the phenomenon of "radiation recall" and "prophylactic agent". Radiation recall dermatitis(RRD) refers to an acute skin inflammatory reaction at the site of previous radiotherapy caused by chemotherapy or targeted therapy. Its incidence rate ranges from 6% to 9% [25]. Due to its specificity, rarity, and unpredictability, most studies on RRD at this stage consist of case reports [26, 27]. With the popularization and advancement of radiotherapy technology, the management of ARD in patients with breast cancer and head and neck cancer has emerged as a prominent topic of interest. This has led to an increase in phase III clinical trials, particularly double-blind studies aimed at evaluating the efficacy of basic preventive measures, such as aloe vera gel and Biafine°. However, the application of these preventive measures primarily relies on clinical experience or physician preference, often neglecting the



Fig. 9 Keyword clustering knowledge graph

Table 7 Major elements of keyword clustering for prevention and management of radiation dermatitis

Cluster	Silhouette	Main research
#0 double blind	0.765	prophylactic agent; phase iii; topical agents; treatment
#1 head and neck cancer	0.731	dermatology life qual- ity index; cancer nurs- ing; patient education; cancer patients
#2 oncology nursing	0.731	adiation dose hypo- fractionation; adjuvant radiotherapy; skin toxicity; head and neck cancer
#3 radiation recall	0.871	radiation recall der- matitis; gemcitabine; breast cancer; breast- conserving treatment
#4 skin	0.743	ionizing radiation; nrf2; cold atmospheric plasma; apoptosis
#5 topical amitriptyline	0.885	hyperbaric oxygen treatment; qualitative; thymine dimers; in situ repair
#6 aloe vera	0.868	radiation induced skin reactions; cancer-free survival; electrospun nanofibrous patches; plant extracts
#7 photobiomodulation	0.732	systematic review; laser therapy; meta-analysis; interferon alpha 2b
#8 acute radiation dermatitis	0.849	wound healing; wound dressing; pelvic neo- plasms; fibroblasts
#9 local application	0.852	ulcer; radiation-protec- tive agents; wr 2721; biological dressings

underlying pathophysiological mechanisms [28]. Consequently, their reference value is limited, and effective, evidence-based intervention methods remain to be established.

The most frequently cited and highest centrality articles represent significant contributions to the prevention and management of RD during the period from 2016 to 2019. The most-cited article, "Management of Acute Radiodermatitis: Literature Review and Treatment Algorithm Recommendations," is a review published by Rosenthal, A [29] in 2019. This review, based on various topical medications and their mechanisms of action for RD, recommends that radiotherapy patients use mild soap and water for daily cleaning based on treatment efficacy. It advocates the use of topical corticosteroids and silver nylon dressings for the treatment of ARD. The article with the highest centrality, "A single-blind, randomized controlled trial of StrataXRT[®] - A silicone-based

film-forming gel dressing for prophylaxis and management of radiation dermatitis in patients with head and neck cancer," was authored by Chan RJ [30] in 2019. In this study, Chan randomly assigned 197 patients receiving radical radiotherapy to the head and neck into an intervention group (StrataXRT[®]) and a standard care group (Sorbolene). The patients' RD was evaluated 4 weeks after the conclusion of radiotherapy. The results indicate that StrataXRT[®] can effectively prevent and delay the occurrence of grade 2 and grade 3 RD in patients with head and neck cancer.

The emergence of two landmark articles has established the significant role of biological dressings in the prevention and management of RD. By integrating the keyword co-occurrence graph and keyword frequency table, and reviewing the relevant literature under each cluster label, it is concluded that, in this phase, in addition to biological dressings, a substantial amount of research has been conducted on the effectiveness of hypofractionated radiotherapy, aloe vera, hyperbaric oxygen therapy (HBOT) and bioregulation therapy.

Hypofractionated radiotherapy refers to a RT approach that achieves comparable or superior therapeutic outcomes compared to conventional radiotherapy by reducing the number of treatment sessions while increasing the dose per session [31]. Implementation of weekly hypofractionated radiotherapy for post-operative breast cancer patients not only maintains skin toxicity levels but also demonstrates a 2-year overall survival rate of 96.8% and a disease-free survival rate of 97.7%, providing compelling evidence for its clinical adoption [32].

Aloe vera, renowned for its anti-inflammatory and analgesic properties, facilitates wound healing. When applied before radiotherapy, it can effectively mitigate erythema and burning sensations in the skin of head and neck cancer patients undergoing radiotherapy and prevent moist RD [33]. However, another study has concluded that the beneficial effects of aloe vera in treating RD are not significant, and its widespread clinical application is not currently recommended [34]. Similarly, although a limited number of studies have reported positive outcomes of hyperbaric oxygen therapy in the treatment of RD, there is presently insufficient evidence to confirm its efficacy [35, 36]. Multiple studies have demonstrated the promising potential of bioregulatory therapy in both preventing and treating RD, specifically in alleviating pain and significantly reducing the risk of grade 3 RD in breast cancer patients [37–39].

It is evident that numerous research findings have emerged during this period. The transition from empirical exploration to more scientific and systematic investigation has significantly advanced the prevention and management of RD.

Top 22 Keywords with the Strongest Citation Bursts

Keywords	Year Stre	ength Begin	End	1995 - 2024
radiation recall	1995	2.38 1995	2014	
radiation-induced dermatitis	1996	2.47 1996	2004	
aloe vera gel	1996	2.47 1996	2011	
prophylactic agent	2004	6.42 2004	2016	
phase iii	2004	4.6 2004	2013	
double blind	2004	4.59 2004	2012	
biafine	2004	2.95 2004	2012	
oncology group rtog	2004	2.45 2004	2005	
breast irradiation	2004	2.23 2004	2012	
hyaluronic acid	2007	2.52 2007	2015	
irradiation	2001	3.23 2008	2010	
pathophysiology	2012	2.95 2012	2018	
head and neck cancer	2012	2.8 2012	2017	
controlled clinical trial	2015	3.49 2015	2018	
randomized controlled trial	2015	2.51 2015	2016	
randomized trial	2011	2.49 2016	2018	
skin toxicity	2004	3.29 2018	2019	
radiodermatitis	2020	2.29 2020	2024	
head	2007	4.89 2021	2022	
adjuvant radiotherapy	2017	2.4 2021	2022	
oncology nursing	2021	2.34 2021	2022	
risk factors	2022	2.37 2022	2024	

Fig. 10 Burst keyword map

The current prevalence of "risk factors" and "assessment tools and treatment" indicates a paradigm shift in research methodology. Research on RD has progressed beyond prevention and treatment, now focusing on prediction and intervention through sophisticated statistical methods and techniques. Wu et al. [40] developed a deep learning platform utilizing Bayesian optimization to predict grade 2 or higher RD in breast cancer patients with high accuracy. This development marks a significant advancement towards personalized medicine in RD management. Hamada, K [41] created a Bayesian probability-based model predicting ARD in head and neck cancer patients with 92.4% accuracy, further highlighting this technique's potential in clinical decision support. Qin, YZ [42] performed a multivariate analysis of 110 nasopharyngeal carcinoma patients, revealing that the pre-radiotherapy Th/Ts ratio significantly correlated with acute skin reaction (OR: 2.29, 95% CI: 1.09-4.79, p < 0.05). Additionally, mid-radiotherapy serum albumin levels < 35 g/L were identified as a significant risk factor for moderate to severe acute radiation skin injury (OR: 6.61, 95% CI: 1.31–33.43, p < 0.05). These findings offer valuable insights for clinical practice.

The implementation of innovative technologies and methodologies has yielded promising outcomes in the prevention and management of RD. Atmospheric cold plasma, generated under normal temperature and pressure conditions and rich in active particles, has demonstrated significant efficacy in promoting cell growth and accelerating wound healing. When applied locally, it can substantially reduce the incidence and severity of RD in breast cancer patients, effectively alleviating symptoms such as pain and itching, thereby contributing to RD prevention and treatment [43, 44]. Hulpusch et al. [45] observed that the skin microbiome composition before, during, and after radiotherapy is associated with severe RD. Kost et al. [46] corroborated that bacterial decolonization can effectively prevent ARD, particularly in breast cancer patients. Robijns et al. [47] developed a novel multi-active emollient and applied it to breast cancer patients undergoing radiotherapy. Their results demonstrated that this new emollient significantly reduced the incidence of RTOG grade 2 skin reactions. Additionally, from the second week to the final radiotherapy session, it decreased the frequency and severity of Sjogren's syndrome.

Significant advancements have been made in the assessment of RD. Pilsniak [48, 49] pioneered the use of dermoscopy for evaluating ARD and CRD in head and neck cancer patients. Their findings revealed that the correlation between dermoscopic and clinical features ranged from 0.03 to 0.54 for acute dermatitis and 0.226 to 0.423 for CRD. Furthermore, Ghaffar [50] introduced the Radiation-Induced Skin Reactions cohort, demonstrating its superior reliability compared to RTOG or CTCAE grades for clinical evaluation.

In summary, the field of RD is currently undergoing a significant transition from conventional treatment approaches to an integrated management model that incorporates advanced technologies. Although phase II validation outcomes have been achieved in exploring risk prediction models, developing novel assessment methods, and implementing innovative treatment modalities, further clinical validation remains essential. Subsequent studies can build upon this foundation to conduct more in-depth explorations, such as establishing large-scale biological databases and developing intelligent systems that integrate prediction, prevention, and intervention.

Limitations

This study employs comprehensive bibliometric analysis to synthesize literature from diverse generations, authors, institutions, and countries/regions. It elucidates the current research landscape and future trends in the prevention and treatment of RD, offering valuable references for subsequent investigations. However, certain limitations persist. Primarily, the study's scope is confined to documents within the WOS Core Collection database, potentially introducing selection bias. Additionally, some recent high-quality publications or those with insufficient citations were not thoroughly analyzed, which may result in inconsistent findings.

Author contributions

ZL, LL, and LF collected all data. ZL, LL, and LF were the main contributors to writing this manuscript. CPJ and YF made critical revisions to this article. All authors contributed to the article and approved the submitted version.

Funding

This study was conducted without external financial support.

Data availability

The datasets used or analyzed in this study are available from the corresponding author on reasonable request.

Declarations

Ethical approval

The WOS database serves as the exclusive source of information for this research. Given that no human subjects participated in this study, ethical informed consent was not necessary.

Informed consent

This article does not contain any studies involving human participants conducted by any of the authors.

Competing interests

The authors declare no competing interests.

Received: 2 August 2024 / Accepted: 25 March 2025 Published online: 16 April 2025

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