

A Bibliometric and Visual Analysis of Chemotherapy- and Radiation Therapy-Induced Oral Mucositis: A Comparative Study between China and the International Literature

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Abstract

Objective: To analyze the current state of research on radiotherapy- and chemotherapy-induced oral mucositis, explore current research hotspots and cutting-edge developments, and provide guidance for the development and advancement of research in this field. **Methods:** We searched for literature on radiotherapy and chemotherapy-induced oral mucositis published between January 1, 2000, and March 15, 2026, using the Web of Science Core Collection and CNKI databases. CiteSpace 6.3.R1 was used to conduct bibliometric and visualization analyses of the literature, examining dimensions such as keyword co-occurrence, clustering, and emergence, as well as the evolution of research over time, authors, institutions, and countries. **Results:** This study analyzed domestic and international literature on radiotherapy and chemotherapy-related oral mucositis (OM) from 2000 to 2026 using CiteSpace. The results showed that international research exhibited characteristics of multicenter and multi-disciplinary collaboration, with core authors and institutions forming stable collaborative networks. Keyword analysis indicated that research hotspots covered basic pathology, radiotherapy and chemotherapy, low-level laser therapy, pharmacological interventions, oral microbiome, and risk prediction models; Domestic research is primarily conducted at university-affiliated hospitals and specialized cancer hospitals, with author collaboration networks concentrated within domestic institutions. Research themes are characterized by clinical nursing, traditional Chinese medicine (TCM) interventions, and specific can-

cer types, showing a trend toward specialized, refined, and evidence-based development from basic symptom management. **Conclusion:** Both domestic and international research on radiotherapy- and chemotherapy-related oral mucositis (OM) exhibits a trend toward mechanistic, precise, and personalized management, moving beyond basic clinical observation. International research is at the forefront in mechanism exploration and predictive model construction, while domestic research is characterized by its focus on clinical nursing and TCM interventions. In the future, efforts should be made to strengthen domestic cross-institutional and international collaboration, promote evidence-based interventions, and improve risk prediction and efficacy evaluation systems. At the same time, the advantages of TCM and nursing optimization should continue to be leveraged to bridge the gap between clinical practice and cutting-edge international research.

Keywords

Radiotherapy and Chemotherapy, Oral Mucositis, CiteSpace, Research Hotspots, Visualization Analysis

1. Introduction

Radiation and chemotherapy are currently among the primary treatment modalities for malignant tumors and are widely used in the management of various solid tumors—such as head and neck cancers, leukemia, and lymphoma—as well as hematologic malignancies [1]. However, while these treatments destroy tumor cells, they often cause damage to normal tissues as well; oral mucositis is one of the most common and painful complications associated with them [2]. It manifests as erythema, edema, erosion, and ulcers of the oral mucosa. In severe cases, it can lead to intense pain, difficulty eating, and deterioration of nutritional status. Localized breakdown also increases the risk of infection and may even necessitate interruption of cancer treatment, significantly impacting patient prognosis and quality of life [3]. Recent systematic reviews indicate that the incidence of oral mucositis (OM) in patients undergoing chemoradiotherapy ranges from 30% to 100%, with the incidence of severe OM reaching 28% to 80%, particularly among patients with head and neck cancers [4] [5]. To address this issue, the 2024-2025 clinical practice consensus issued by the international multidisciplinary organizations MASCC/ISOO emphasizes a comprehensive strategy ranging from prevention-oriented approaches, systematic assessment, and early intervention, multidisciplinary collaboration, and individualized management. These include interventions such as basic oral care, nutritional and pain support, low-level laser therapy (LLLT), and oral cryotherapy. These methods have been validated by multiple randomized controlled trials and systematic reviews as effective in reducing the incidence of severe OM and improving patients' quality of life [6]-[8].

However, due to differences in the timing of research initiation, clinical practice

environments, cultural backgrounds, and medication practices, there are significant disparities between domestic and international contexts regarding the trends in oral mucositis (OM), intervention strategies, research priorities, and models of international collaboration. For example, research on OM abroad not only covers systematic reviews and meta-analyses of basic mechanisms and non-pharmacological and pharmacological interventions but is also gradually expanding from single-treatment approaches toward comprehensive management and risk prediction, whereas studies in Asia and other low- and middle-income countries indicate that OM management in clinical practice rarely follows evidence-based guidelines and that supportive oral care measures are inadequately implemented, reflecting regional differences in nursing resources, guideline implementation, and clinical pathways [9]. Furthermore, recent studies indicate that the prevalence, severity assessment, and intervention methods for OM also vary by region, potentially driven by factors such as differences in clinical practices, supportive care systems, and the influence of culture on self-management behaviors [10]. From the perspective of research trends, recent international studies on oral mucositis (OM) have mainly focused on constructing and optimizing risk prediction models using large-sample and multicenter data to enhance early identification and individualized risk stratification. For example, a systematic review by Tao *et al.* in 2025 summarized existing chemotherapy-induced OM risk prediction models, noting that most models reported good discriminatory performance (AUC 0.630 - 0.966), but overall there was a risk of bias. The review recommended that future studies adopt more rigorous methodological standards for model development and external validation to facilitate the clinical application of standardized risk prediction tools [11]. In contrast, domestic research on radiotherapy and chemotherapy-related OM in China shows distinctive methodological and thematic trends. For instance, in a randomized controlled trial conducted in patients with nasopharyngeal carcinoma, Jiandu granules—a traditional Chinese medicine compound—significantly reduced the incidence of severe OM (Grade III - IV) in patients receiving concurrent chemoradiotherapy, with good safety profiles. This suggests that TCM formulations may have potential protective effects against the development of OM as an adjunctive intervention [12].

Bibliometrics, relying on mathematical and statistical methods, can objectively and systematically analyze the overall structure, development history, and influence of a research field. Combined with visualization tools such as CiteSpace, it can deeply mine core information from the literature and present the evolution of research hotspots and international collaboration patterns [13]. Currently, bibliometric research on radiotherapy- and chemotherapy-related oral mucositis is insufficient, lacking systematic comparative analyses between domestic and international studies, making it difficult to comprehensively reflect global research disparities and trends. Based on this, this study selected China National Knowledge Infrastructure (CNKI) and the Web of Science Core Collection (Wo SCC) as data sources, collecting all domestic and international literature related to radiother-

apy- and chemotherapy-related oral mucositis from 2000 to 2026, CiteSpace software was employed to conduct bibliometric analysis and construct a knowledge map, with the aim of comprehensively mapping the current research status, developmental trajectory, and existing gaps in the field of radiotherapy and chemotherapy-related oral mucositis. This study seeks to provide reliable data support and scientific decision-making references for future research in this field in China.

2. Materials and Methods

2.1. Literature Search

A dual-database strategy was employed, covering both domestic and international sources. English-language literature was searched in the Web of Science Core Collection (WoSCC) database, while Chinese-language literature was searched in the China National Knowledge Infrastructure (CNKI) database. The search time frame was set from January 1, 2000, to March 15, 2026. All search operations were completed by March 15, 2026. Relevant literature published after the search was not included to ensure the timeliness and accuracy of the search results (Figure 1).

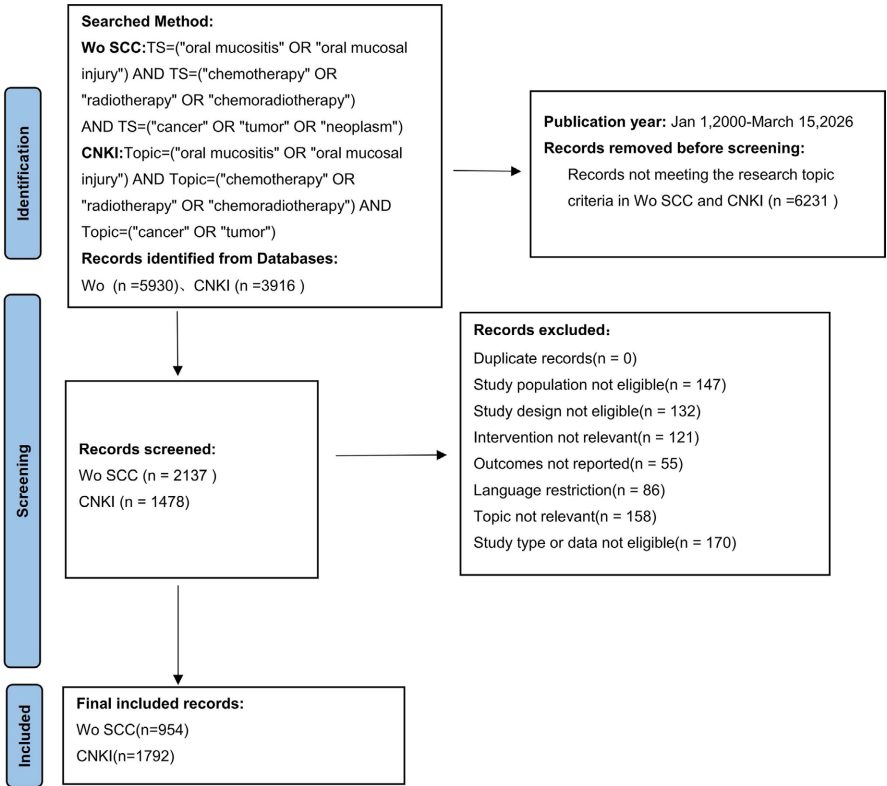


Figure 1. Flowchart of the study.

2.2. Inclusion and Exclusion Criteria

The inclusion criteria were as follows:

- Study population: Cancer patients receiving radiotherapy or chemotherapy

who developed oral mucositis.

- Study type: Randomized controlled trials (RCTs), cohort studies, case-control studies, systematic reviews, and meta-analyses.
- Interventions: Preventive or therapeutic strategies for oral mucositis related to radiotherapy or chemotherapy, including pharmacological, physical, or combined interventions.
- Outcome measures: Incidence and severity of oral mucositis, pain scores, quality of life, or related adverse events.
- Language: Chinese or English.

Exclusion criteria included:

- Studies unrelated to the topic (e.g., only basic experimental or mechanistic research).
- Case reports, expert opinions, conference abstracts, or articles without full text available.
- Studies with incomplete data or insufficient outcome measures for extraction.
- Non-human studies (e.g., animal experiments).

2.3. Literature Screening Process

- Initial screening: Two reviewers independently screened titles and abstracts to exclude clearly irrelevant studies.
- Full-text review: Remaining studies were assessed in full text to determine final inclusion.
- Discrepancy resolution: Any disagreements were resolved through discussion with a third reviewer.

3. Results

3.1. Analysis of Annual Publication Volume

This study ultimately included 954 English-language papers and 1792 Chinese-language papers. English-language publications experienced a slow initial phase from 2000 to 2011, with most years seeing fewer than 20 papers. After 2012, they entered a period of steady growth, reaching 82 papers in 2023 and peaking at 118 papers in 2025, before declining to 16 papers in 2026 (as of the latest data); Chinese publications experienced explosive growth from 2010 to 2019, maintaining a range of 74 - 116 articles, peaking at 116 in 2017, and then declining significantly starting in 2020, dropping to 47 in 2025 and 13 in 2026 (as of the latest data). Overall, domestic research activity exceeded that of international research prior to 2022, but has declined annually since 2019 (**Figure 2**).

3.2. Analysis of Author Co-Occurrence Networks

This study used CiteSpace to construct and visualize co-occurrence networks of domestic and international authors. The results indicate significant differences in the characteristics of academic collaboration within the medical field between domestic and international researchers. Specifically, the international author

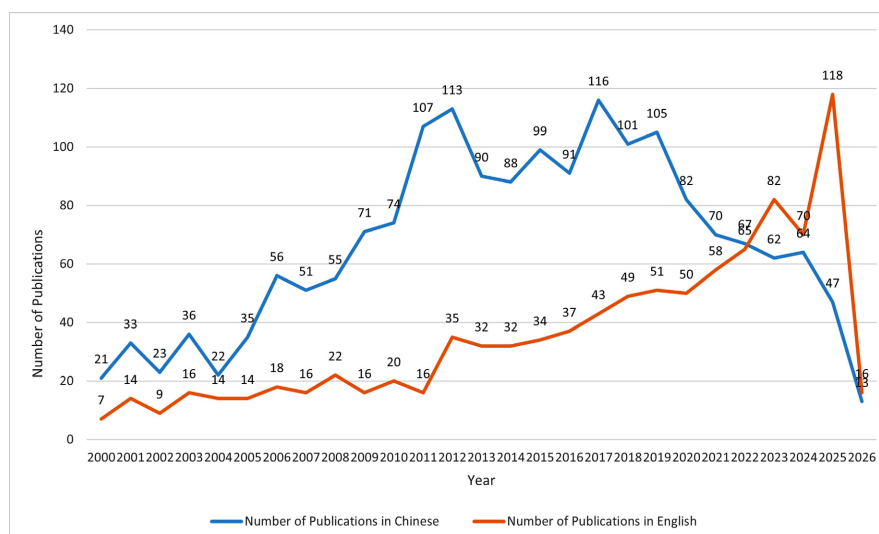


Figure 2. Analysis of annual publication volumes in the field of nursing, both domestic and international, 2000-2026.

network exhibits a polycentric and widely distributed pattern, with Malecka-Masalska, Teresa; Bossi, Paolo; and Sonis, Stephen T. serving as core nodes. Stable collaborative subgroups have formed among these core authors and across regions (e.g., Chinese scholars such as Li Zixia and Tian Xu). The network density is moderate, featuring both closely collaborating core teams and a significant number of independent researchers (**Figure 3**). This finding aligns with previous research conclusions—in the CiteSpace visualization analysis of the Clinical Decision Support Systems (CDSS) field, multiple core authors and transnational collaborative relationships were similarly identified, reflecting close collaboration among scholars in Europe and the United States, as well as between European/American and Chinese scholars, and mirroring the globalizing trend in medical research [14]. In contrast to the international network, the domestic author network exhibits highly centralized and clustered characteristics. With Gao Liying, Liu Yunxia, Jia Qun, and Liu Jianhong as core nodes, these core authors form tight-knit collaborative sub-groups with surrounding scholars (such as Shen Honghai, Gu Yanhong, and Ding Xiaoping). Collaboration is primarily intra-institutional and intra-regional, with relatively weak cross-team collaboration, presenting an overall “core-periphery” structure (**Figure 4**).

3.3. Co-Occurrence Analysis of Institutional Networks

Institutional co-occurrence networks provide a visual representation of the geographical distribution of research capabilities, collaboration patterns, and the influence of core institutions. At the international level, institutional collaboration networks exhibit characteristics of multi-centered, cross-regional collaboration: Harvard University Medical Affiliates, Harvard University, and Brigham & Women’s Hospital serve as core nodes, with publication frequencies of 23, 23, and 20, respectively, indicating high centrality. This trend aligns with the findings

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 TimeSpan: 2000-2026 (Slide Length:1)
 Selection: G-Index: 0.92496 (k=25) LRF=2.5, LRI=10, LBY=5, e=1.0
 Network: 10789, E=264 (Density=0.0009)
 Nodes Labeled: 1.0%
 Pruning: MST
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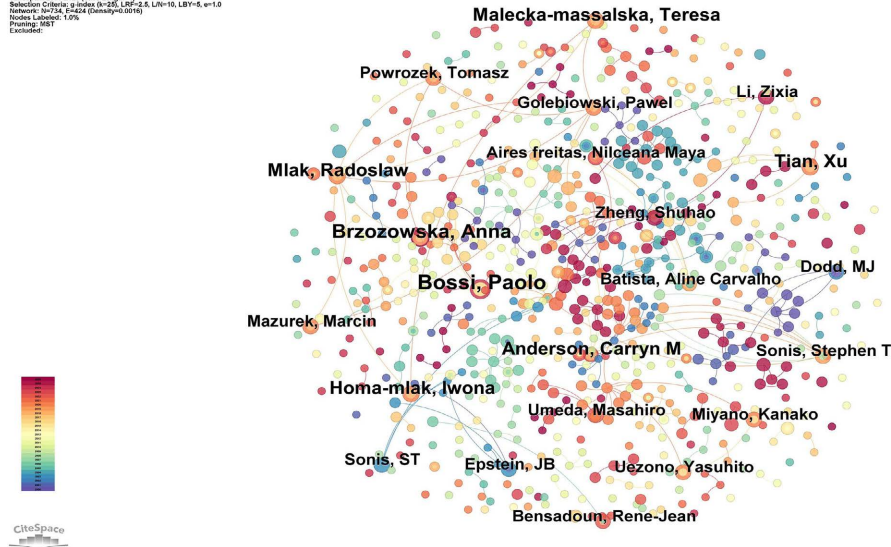


Figure 3. Co-occurrence network analysis of authors in English-language studies on chemotherapy- and radiation therapy-related oral mucositis, 2000-2026.

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 TimeSpan: 2000-2026 (Slide Length:1)
 Selection: G-Index: 0.92496 (k=25) LRF=2.5, LRI=10, LBY=5, e=1.0
 Network: 10789, E=264 (Density=0.0009)
 Nodes Labeled: 1.0%
 Pruning: MST
 Modularity Q=0.6193
 Weighted Mean Silhouette S=0.8294
 Harmonic Mean(Q, S)=0.8387
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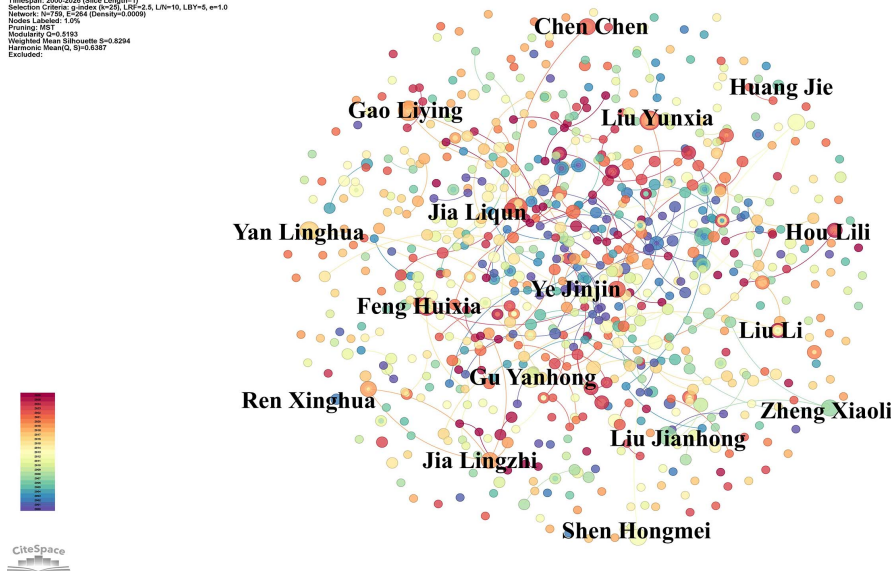


Figure 4. Co-authorship network analysis of non-English studies on chemotherapy- and radiotherapy-induced oral mucositis, 2000-2026.

of recent CiteSpace-based studies on global healthcare and health systems collaboration networks. Such studies generally find that European and American institutions occupy central positions in global healthcare collaboration networks, playing a dominant role in shaping research priorities and knowledge dissemination. They also emphasize that collaborative links between transnational institutions are crucial for global health science research, noting that international cooperation in fields such as integrated care still has room for improvement to drive knowledge co-creation and model innovation [15]. Notably, Chinese institutions

such as Sichuan University and Sun Yat-sen University have also joined the international core network, forming cross-regional collaborative links with European and American institutions such as the Dana-Farber Cancer Institute and the University of California System. This reflects the continuous increase in the participation of Chinese institutions in global medical research collaboration [16] (Figure 5 and Table 1).

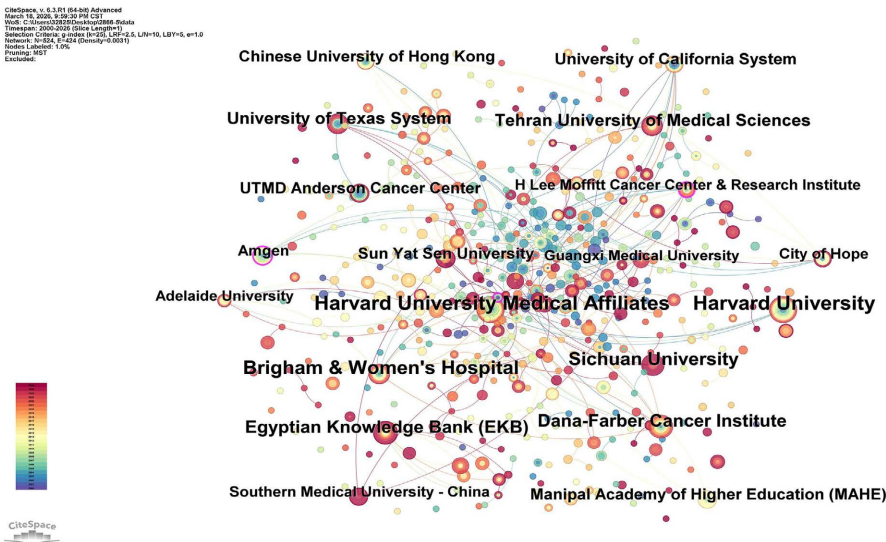


Figure 5. Co-occurrence analysis of English-language institutional networks related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

Table 1. Top 10 institutions by number of published papers on chemotherapy- and radiotherapy-induced oral mucositis, 2000-2026.

Rank	Frequency	Centrality	Year	Organization
1	23	0.09	2001	Harvard University Medical Affiliates
2	23	0.00	2001	Harvard University
3	20	0.07	2001	Brigham & Women’s Hospital
4	17	0.00	2010	Sichuan University
5	15	0.02	2003	Dana-Farber Cancer Institute
6	15	0.00	2009	Egyptian Knowledge Bank (EKB)
7	13	0.00	2012	Tehran University of Medical Sciences
8	13	0.04	2003	University of Texas System
9	11	0.04	2000	University of California System
10	10	0.00	2006	Manipal Academy of Higher Education (MAHE)

At the domestic level, the co-occurrence network of institutions exhibits characteristics of high concentration and regional clustering: the core nodes are Bei-

jing University of Chinese Medicine, the Cancer Center of Sun Yat-sen University, and Zhejiang University of Traditional Chinese Medicine, with publication frequencies of 8, 6, and 5, respectively, making them the primary research hubs in this field within China. Most core institutions are TCM universities and their affiliated hospitals. They form close cooperative sub-clusters with regional medical institutions such as the Nantong Cancer Hospital in Jiangsu Province and the Affiliated Hospital of Nantong University. The cooperative model is primarily based on intra-institutional and intra-regional collaboration, while cross-regional collaboration remains relatively weak. Apart from the core clusters, collaborative ties among most regional hospitals or affiliated institutions of local medical colleges are weak. The network as a whole exhibits a distinct “core-periphery structure”, wherein a small number of core institutions dominate research directions and resource allocation, while the majority of institutions—despite their large numbers—remain on the periphery of the network. This aligns with recent CiteSpace analysis results in the medical field, suggesting that there is still significant room for improvement in establishing broader institutional collaboration networks in China [17] (Figure 6 and Table 2).

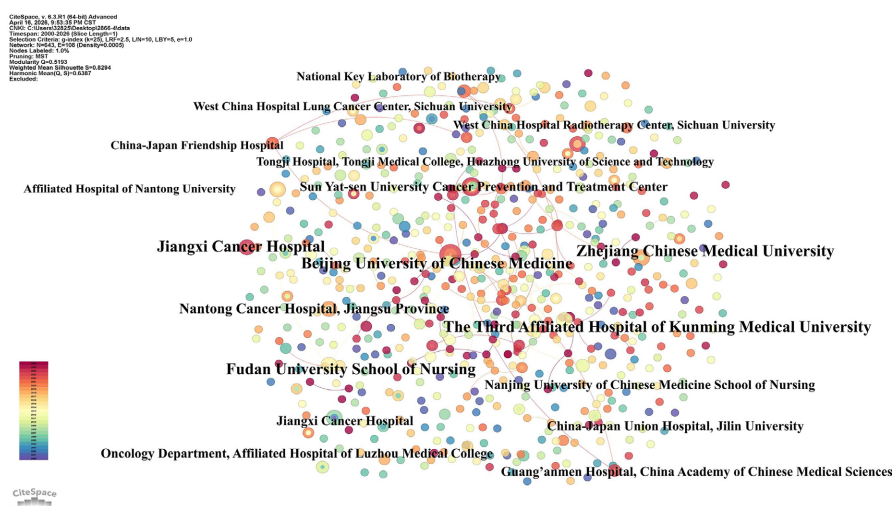


Figure 6. Co-occurrence analysis of non-English-language institutions related to chemotherapy- and radiation-induced oral mucositis, 2000-2026.

Table 2. Top 10 institutions by number of published papers on non-English studies of chemotherapy- and radiation therapy-related oral mucositis, 2000-2026.

Rank	Frequency	Centrality	Year	Organization
1	8	0	2018	Beijing University of Chinese Medicine
2	6	0	2006	Sun Yat-sen University Cancer Center
3	5	0	2009	Zhejiang University of Traditional Chinese Medicine
4	4	0	2022	Jiangxi Provincial Cancer Hospital
5	4	0	2015	Nantong Cancer Hospital, Jiangsu Province

Continued

6	4	0	2013	Affiliated Hospital of Nantong University
7	4	0	2018	Tongji Hospital, Affiliated to Tongji Medical College of Huazhong University of Science and Technology
8	4	0	2000	Jiangsu Provincial Cancer Hospital
9	4	0	2012	The Third Affiliated Hospital of Kunming Medical University
10	4	0	2013	School of Nursing, Fudan University

3.4. Keyword Analysis

3.4.1. Keyword Co-Occurrence Network Analysis

The keyword co-occurrence network provides a visual representation of the research hotspots and core themes in the field of radiotherapy and chemotherapy-related oral mucositis. At the international level, “oral mucositis” is the absolute core node in this field, with a frequency of 431 and a centrality of 1.03. Research clusters centered around “head and neck cancer” (frequency: 168, centrality: 0.51) and “radiation therapy” (frequency: 37, centrality: 0.10) have formed around this node, extending into sub-themes such as “prevention”, “management”, “quality of life”, and “risk factors”. This reflects a global research focus on the prevention and comprehensive management of oral mucositis caused by radiotherapy and chemotherapy, as well as its impact on patients’ quality of life. Concurrently, research also covers intervention methods such as stem cell transplantation, low-level laser therapy, and photobiomodulation/photodynamic therapy. Relevant reviews and systematic evaluations have confirmed that laser-based interventions can effectively alleviate the pathological manifestations and symptoms of chemotherapy- and radiotherapy-related oral mucositis and improve patients’ quality of life [18] [19]. Overall, the international keyword network exhibits a “core-multi-branch” structure, with diverse research directions that are closely interrelated (Figure 7 and Table 3).

At the domestic level, “oral mucositis” serves as the core keyword, with a frequency of 459 and a centrality of 0.30. It is closely associated with “chemotherapy” (frequency 432, centrality 0.25), oral ulcers (frequency 423, centrality 0.29), nasopharyngeal cancer (frequency 283, centrality 0.17), and nursing (frequency 209, centrality 0.23), forming a tightly interconnected core cluster. This characteristic is closely related to the focus of Chinese research on clinical practice, nursing interventions, and TCM prevention and treatment strategies. For example, systematic reviews indicate that various natural products and TCM-related interventions demonstrate potential benefits in improving symptoms of radiotherapy-induced oral mucositis, reducing the severity of the condition, and alleviating pain and dry mouth, and are associated with improved quality of life. This further corroborates the emphasis of domestic research on practical interventions and TCM prevention

and treatment approaches [20]. The overall network exhibits a clustered distribution with prominent core themes (**Figure 8** and **Table 3**).

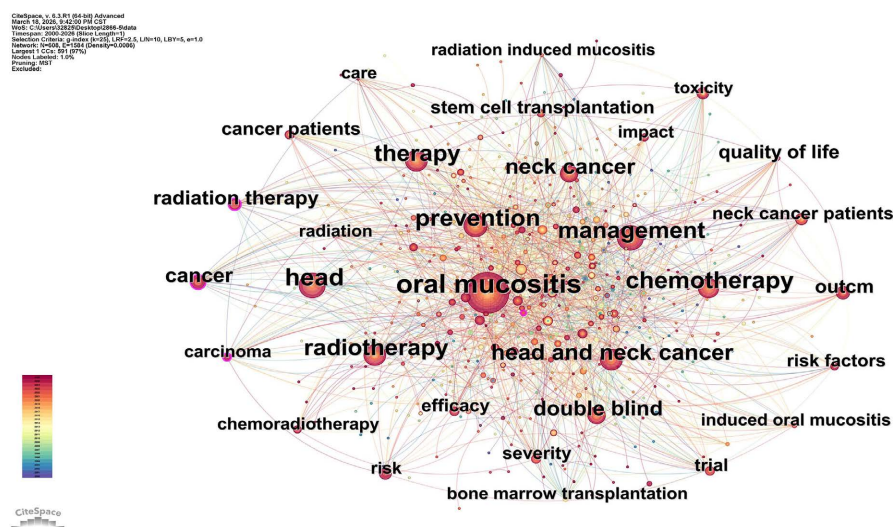


Figure 7. Co-occurrence network analysis of English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

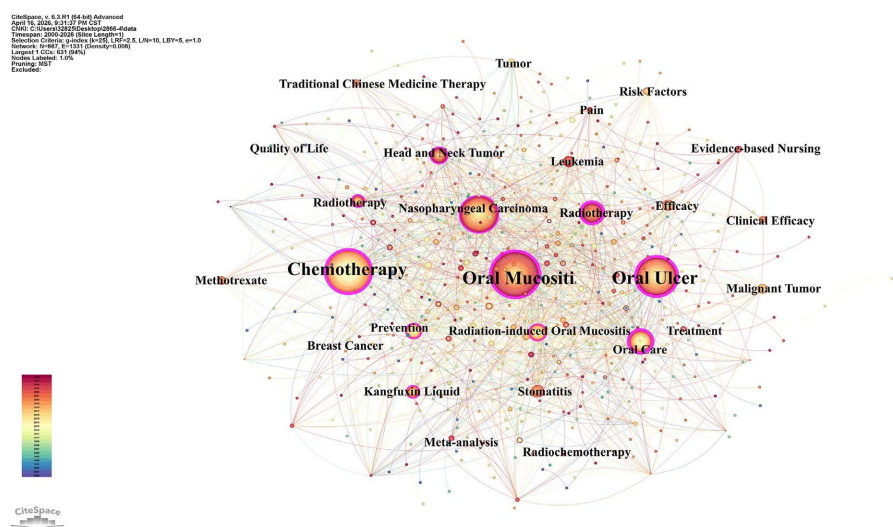


Figure 8. Co-occurrence network analysis of non-English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

Table 3. Top 20 high-frequency keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

Rank	Non-English Keyword	Frequency	Centrality	English Keyword	Frequency	Centrality
1	Oral Mucositis	459	0.3	Oral Mucositis	431	1.03
2	Chemotherapy	432	0.25	Head and Neck Cancer	168	0.51
3	Oral Ulcers	423	0.29	Radiation Therapy	37	0.10
4	Nasopharyngeal Cancer	283	0.17	Nasopharyngeal Carcinoma	32	0.14
5	Nursing Care	209	0.23	Quality of Life	22	0.05

Continued

6	Radiotherapy	186	0.26	Radiation-Induced Oral Mucositis	19	0.06
7	Stomatitis	136	0.12	Risk Factors	17	0.02
8	Radiation Therapy	92	0.14	Head and Neck Neoplasms	16	0.04
9	Radiation-Induced Stomatitis	90	0.15	Systematic Review	16	0.02
10	Leukemia	82	0.06	Low-Level Laser Therapy	15	0.04
11	Head and Neck Tumors	81	0.14	Drug Therapy	13	0.03
12	Huanxingxin Solution	68	0.08	Oral Cancer	13	0.04
13	Oral Care	56	0.12	Oral Care	12	0.03
14	Chemoradiotherapy	54	0.07	Head-and-Neck Cancer	11	0.02
15	Nursing Interventions	46	0.07	Chemotherapy-Induced Oral Mucositis	10	0.01
16	Prevention	39	0.05	Breast Cancer	9	0.04
17	Cancer	39	0.08	Head and Neck Cancers	9	0.02
18	Radiotherapy	36	0.09	Laser Therapy	8	0
19	Malignant Tumors	34	0.08	Zinc Sulfate	8	0
20	Methotrexate	33	0.02	Hematopoietic Stem Cell Transplantation	7	0

3.4.2. Keyword Cluster Analysis

The keyword cluster analysis reveals that international research centers on the core cluster #0 oral mucositis, from which nine thematic clusters have emerged: #1 head and neck cancer, #3 radiation therapy, #2 low-level laser, #7 quality of life, #8 risk factors, and #6 oral microbiota, forming a multidimensional knowledge structure of “core disease—tumor type—intervention technique—prognosis and mechanisms”. This research encompasses both radiotherapy and chemotherapy as well as novel physical intervention methods, while also extending into areas such as disease risk, quality of life, and the mechanisms of the oral microbiome (Figure 9). Relevant studies indicate that the oral microbiome is closely associated with radiation-induced oral mucositis; interventions that modulate the microbiome—such as the use of probiotics—may mitigate the onset and progression of radiation-induced mucositis, reflecting cutting-edge international research on mechanisms and novel intervention technologies [21] [22]. In contrast, domestic research centers on a core cluster of #0 radiotherapy and chemotherapy, from which nine thematic clusters have emerged, including stomatitis, oral ulcers, leukemia, nasopharyngeal cancer, nursing, and rehabilitation. This presents a practice-oriented structure of “treatment modalities—clinical complications—disease management—nursing and TCM interventions”, emphasizing clinical nursing and TCM-specific prevention and treatment, and aligning closely with clinical application scenarios (Figure 10).

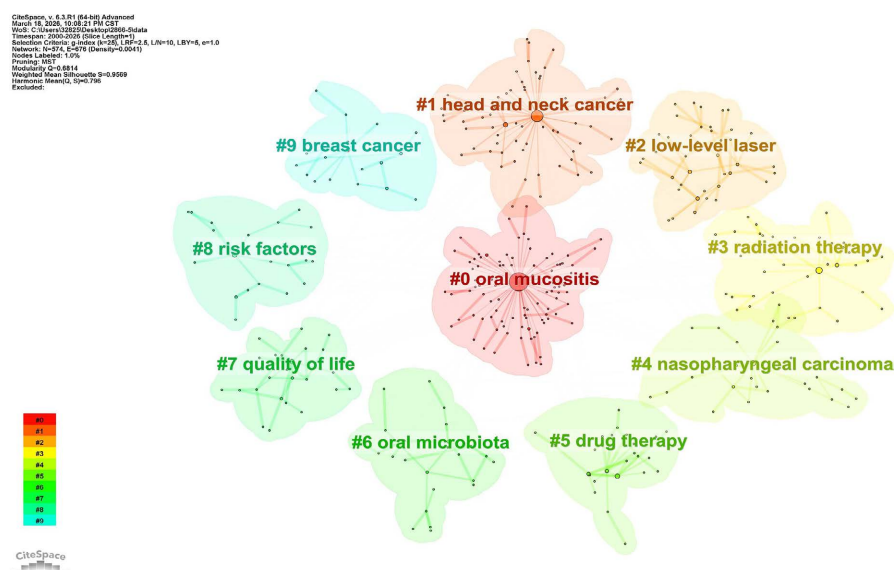


Figure 9. Cluster analysis of English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

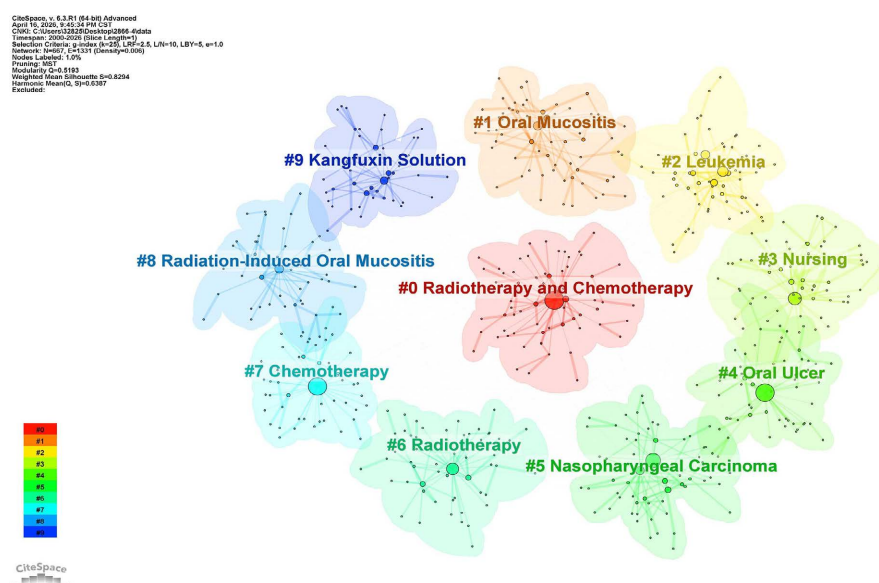


Figure 10. Cluster analysis of non-English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

3.4.3. Keyword Burst Analysis

Keyword trend analysis reveals the evolving trends in research hotspots related to radiotherapy- and chemotherapy-induced oral mucositis. Specifically, this can be divided into two levels: international and domestic. At the international level, early research primarily focused on basic symptoms such as oral pain and radiation mucositis, as well as the clinical manifestations of radiotherapy-induced mucositis. After 2010, the focus gradually shifted toward exploring underlying mechanisms and intervention models, such as elemental diets and mouse models. Over the past decade (since 2020), there has been a concentrated surge in research on

chemotherapy-induced oral mucositis, radiation-induced oral mucositis, nasopharyngeal carcinoma, risk factors, oral microbiota, and prediction models. This reflects a shift in research focus from simple symptom descriptions toward cutting-edge areas such as precise classification, risk assessment, microbiome mechanisms, and the development of prediction models (Figure 11). At the domestic level, early research primarily centered on clinical symptoms such as oral ulcers and basic nursing care. After 2010, the focus gradually shifted toward specific diseases like leukemia and the exploration of refined nursing models. Since 2020, keywords such as chemotherapy- and radiotherapy-related oral mucositis, head and neck cancer, quality of life, and head and neck tumors have maintained a high intensity of research activity. Concurrently, research methods such as meta-analysis and the use of rehabilitation solutions, along with TCM-specific intervention themes, have also emerged as hotspots (Figure 12), reflecting the evolution of domestic research from basic nursing toward evidence-based research, specialized interventions, and the management of specific disease conditions [23].

Top 25 Keywords with the Strongest Citation Bursts

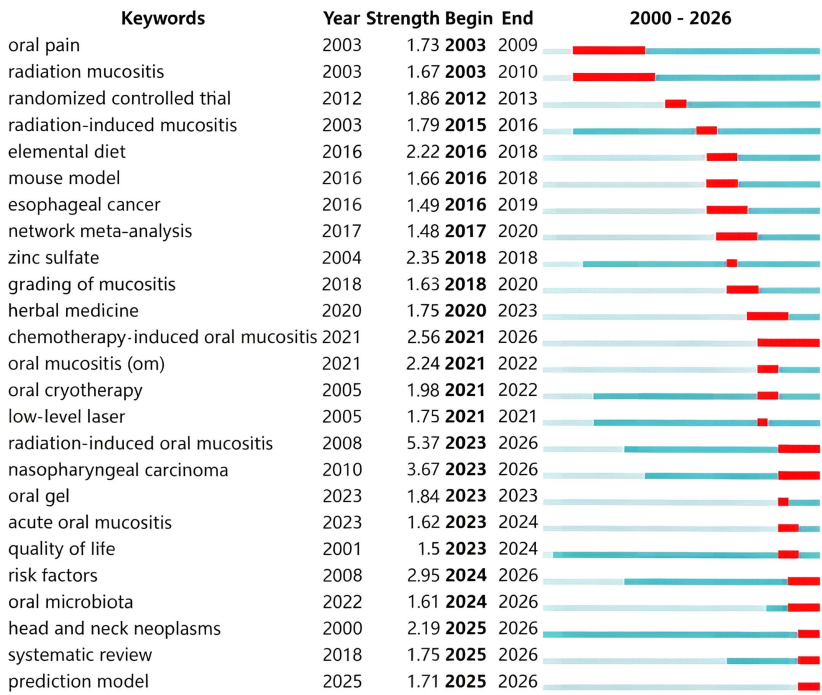


Figure 11. Trend analysis of English keywords related to chemotherapy- and radiation-induced oral mucositis, 2000-2026.

3.4.4. Analysis of the Timeline of Keywords

The keyword timeline analysis provides a visual representation of the evolution of research themes in the field of chemotherapy- and radiation therapy-related oral mucositis. At the international level, research centered on #0 oral mucositis has been a consistent focus. Early studies primarily addressed the basic symptoms of mucositis associated with clinical conditions such as head and neck cancer and

Top 25 Keywords with the Strongest Citation Bursts

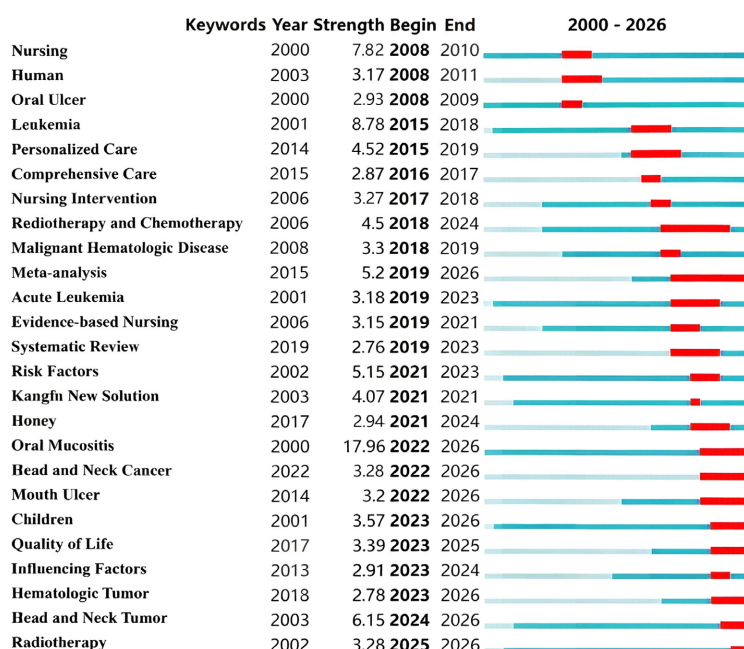


Figure 12. Analysis of non-English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

radiation therapy. Subsequently, the scope gradually expanded to include intervention studies covering physical interventions (e.g., low-level laser therapy) and pharmacological treatment strategies (e.g., drug therapy). In recent years, research has increasingly focused on mechanisms and predictive aspects such as oral microbiota, risk factors, and prediction models. This reflects the field's transition from early symptom descriptions and exploratory interventions toward cutting-edge developments in precise classification, risk assessment, microbiome mechanisms, and the construction of predictive models (Figure 13).

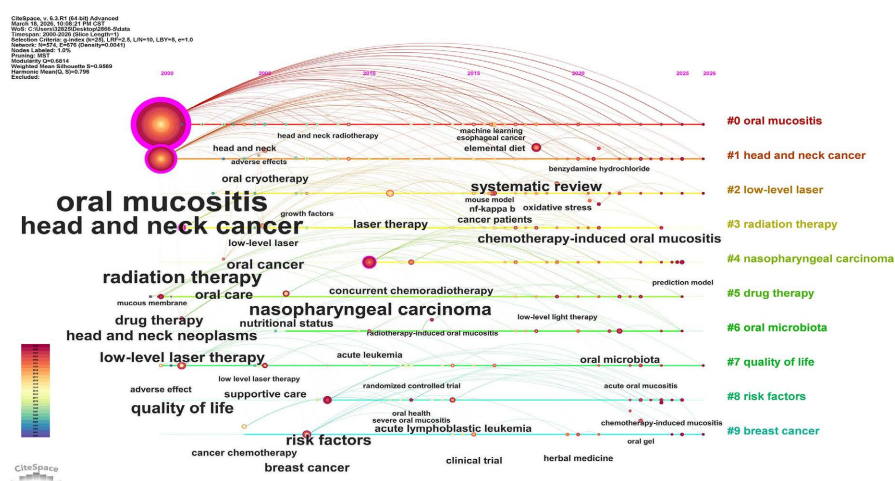


Figure 13. Timeline analysis of English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

At the domestic level, the keyword timeline indicates that early research concentrated on clinical symptoms such as oral ulcers and basic nursing measures. As clinical needs became more specialized, the scope gradually expanded to include specific conditions such as leukemia and nasopharyngeal cancer, along with corresponding refined nursing models. In recent years, high-impact themes centered on radiotherapy and chemotherapy, rehabilitation, refined management of radiotherapy and chemotherapy, and patient quality of life have remained active. Concurrently, topics involving evidence-based research methods such as meta-analysis and distinctive traditional Chinese medicine (TCM) interventions have gradually emerged, reflecting the evolution of domestic research from basic nursing toward evidence-based practice, specialized disease management, and practice-oriented TCM interventions (Figure 14).

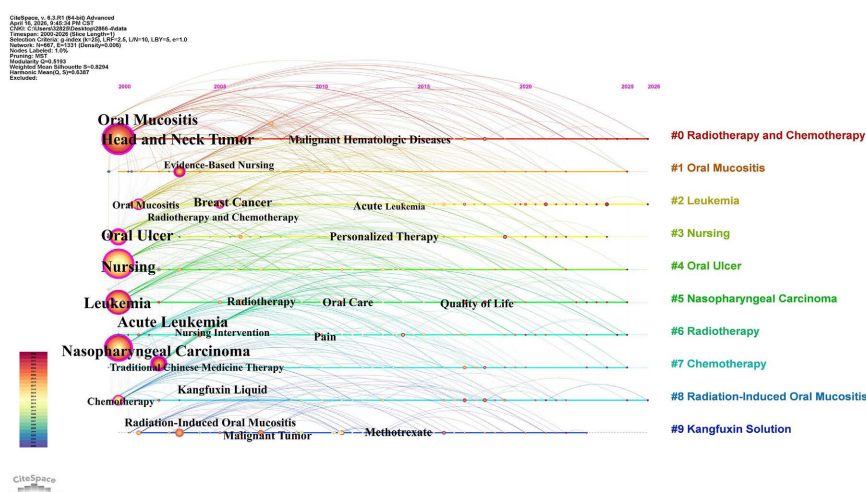


Figure 14. Timeline analysis of non-English keywords related to chemotherapy- and radiation-induced oral mucositis, 2000-2026.

3.4.5. Analysis of the Keyword Heatmap

The keyword heatmap clearly illustrates the temporal distribution and trends in research topics related to chemotherapy- and radiotherapy-induced oral mucositis. At the international level, “oral mucositis” has consistently maintained high prominence, serving as a core theme throughout the entire period, while “head and neck cancer” is highly correlated with it, reflecting the close relationship between tumor type and the clinical manifestations of mucositis. The gradual rise in popularity of mechanism- and prognosis-related topics in recent years—such as oral microbiota, risk factors, and prediction models—aligns with the latest research trends. For instance, imbalances in the oral microbiome are considered associated with the onset and progression of mucositis, while the identification of risk factors (such as pre-existing oral diseases and combined chemotherapy regimens) and the development of prediction models are recognized by multiple systematic reviews and meta-analyses as key directions for precise prevention and control [11] [24] (Figure 15).

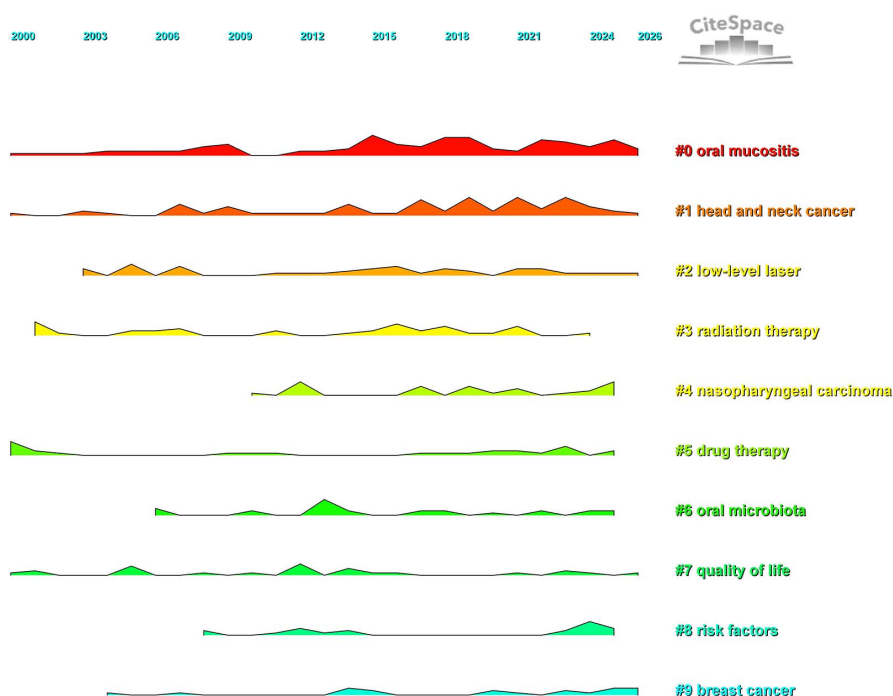


Figure 15. Cluster analysis of English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

At the domestic level, the popularity of radiotherapy and chemotherapy as core themes remained consistent throughout the entire period. Topics related to complications and nursing—such as stomatitis, nursing care, and oral ulcers—peaked early on and remained stable over the long term, reflecting the long-standing emphasis in Chinese research on clinical nursing and intervention practices for symptoms associated with radiotherapy and chemotherapy; As research progressed, topics related to specific diseases such as nasopharyngeal cancer and leukemia, as well as traditional Chinese medicine (TCM) interventions like rehabilitation solutions, gradually gained prominence in the middle and later stages. Meanwhile, the popularity of treatment-related topics such as radiotherapy and chemotherapy continued to fluctuate, demonstrating ongoing domestic research efforts in the management of specific clinical conditions, nursing optimization, and TCM-based prevention and treatment (**Figure 16**).

3.4.6. Keyword Timeline

Foreign research shows that early studies (2000-2010) primarily focused on foundational topics such as oral mucositis, chemotherapy, radiotherapy, and head and neck cancer, with an emphasis on clinical trial designs, including double-blind trials and stem cell transplantation. From 2011 onward, research gradually shifted toward risk stratification, mechanistic investigations, and patient-centered outcomes, with keywords such as severity, pathogenesis, quality of life, and biomarkers becoming increasingly prominent. In recent years (2020-2026), research interests have further expanded to adjunctive interventions, supportive care, and

treatment-related side effects, with topics such as pediatric patients, oxidative stress, supplementation, and weight loss emerging. The size and color intensity of nodes reflect the frequency and centrality of topics, highlighting the evolving focus of oral mucositis research over time (Figure 17).

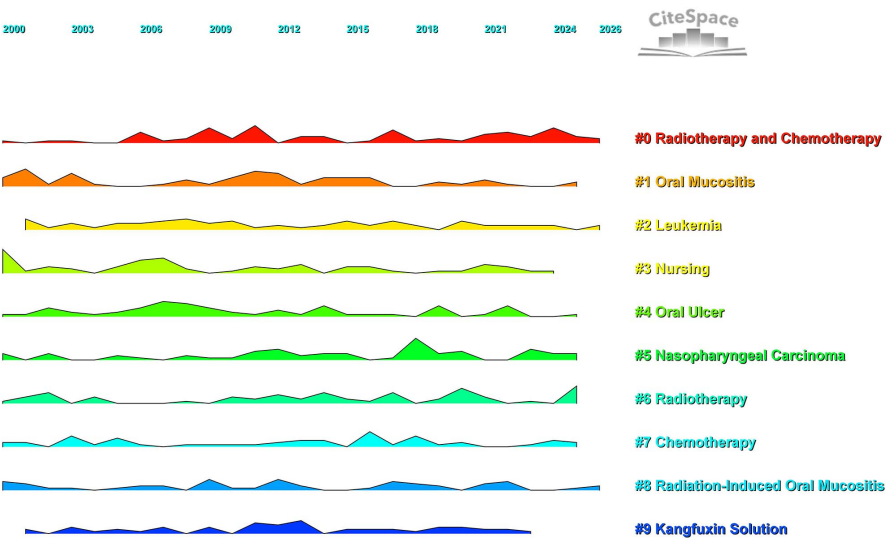


Figure 16. Cluster analysis of non-English keywords related to chemotherapy- and radiotherapy-induced oral mucositis, 2000-2026.

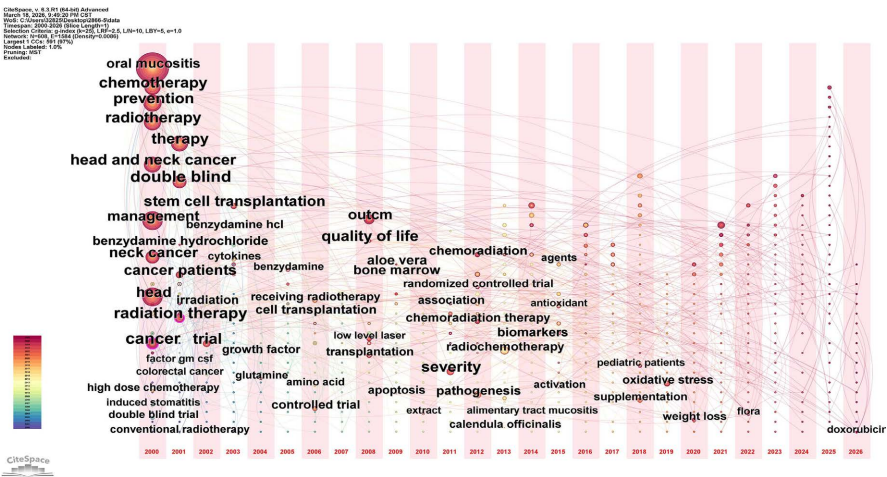


Figure 17. Time-region analysis of English keywords related to chemotherapy- and radiation therapy-induced oral mucositis, 2000-2026.

In domestic research, early studies (2000-2005) primarily addressed basic complications, including oral mucositis, radiation-induced stomatitis, oral ulcers, and stomatitis, while also exploring treatment-related topics such as radiotherapy, chemotherapy, and radiation therapy. Early explorations of traditional Chinese medicine (TCM) interventions, including the “Rehabilitation New Solution” and integrated TCM-Western medicine approaches, also began to emerge. During the mid-period (2006-2015), research gradually shifted toward specific disease areas,

3.4.7. Co-Citation Analysis

235

network density is high, and core publications have formed stable knowledge connections with subsequent research, reflecting the field's clear research trajectory and the enduring influence of its core literature.

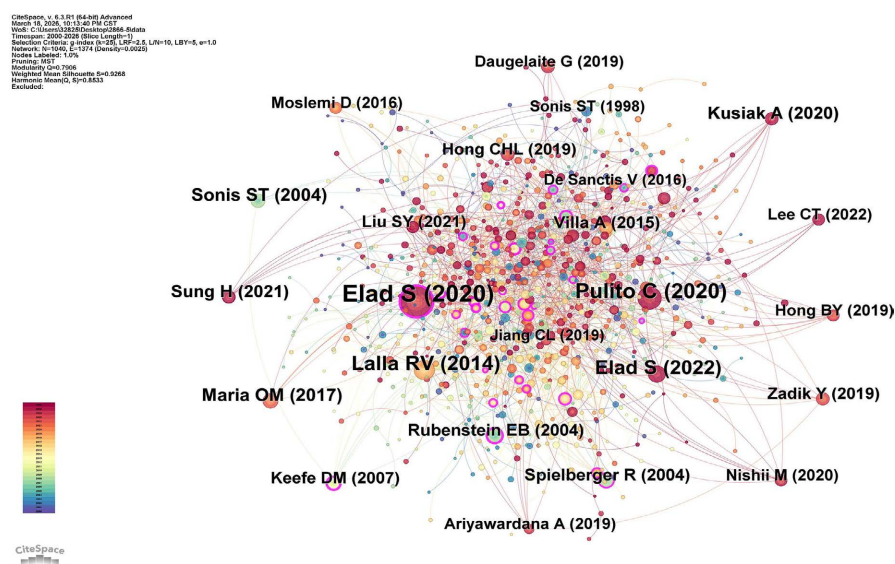


Figure 19. Citation network analysis of English-language literature on chemotherapy- and radiation therapy-related oral mucositis, 2000-2026.

4. Discussion

4.1. Analysis of the Current Status of Chemotherapy- and Radiation Therapy-Induced Oral Mucositis in China

4.1.1. Research Interest Continues to Rise; English-Language Publications Have Surpassed Chinese-Language Publications for the First Time in Recent Years

In recent years, research interest in radiotherapy- and chemotherapy-related oral mucositis in China has continued to rise, with the total annual number of publications showing steady growth. Research content has gradually expanded from early observations of clinical symptoms to multiple dimensions, including exploration of pathogenesis, analysis of risk factors, standardized nursing interventions, integrated traditional Chinese and Western medicine prevention and treatment, nutritional support strategies, and evaluation of patients' quality of life, with the interdisciplinary nature of the field becoming increasingly prominent. For example, a bibliometric study based on SCOPUS data analyzed the publication volume, author and institutional collaboration networks, and national contributions of literature on "oral mucositis", providing empirical evidence for understanding the academic activity and collaboration patterns in this field [25]. Furthermore, bibliometric analyses focusing on specific therapeutic interventions (such as photobiomodulation) and other oral diseases have similarly revealed an increase in English-language publications and the expansion of international collaboration [26].

Consequently, with increasingly standardized research designs, the accumulation of evidence-based data, and the growth of international publications, the

number of articles by Chinese scholars in English-language journals such as SCI has continued to rise. For the first time, the total number of English-language publications has surpassed that of Chinese-language publications. This not only signifies a steady improvement in the quality and academic influence of China's research on oral mucositis caused by radiotherapy and chemotherapy but also reflects the field's transition from summarizing local experience to conducting high-level, evidence-based international research, with research findings gradually gaining recognition from the international peer community. Looking at specific publication data, between 2000 and 2026, the total number of Chinese-language publications in this field was 1792, while the total number of English-language publications was 954. Specifically, the number of Chinese-language publications peaked in 2012 and has since shown a fluctuating downward trend, dropping to 47 by 2025; conversely, the number of English-language publications has been on a steady upward trajectory since 2011, reaching 118 by 2025—the first time it has surpassed the number of Chinese-language publications. This quantitative shift further corroborates the strengthening trend toward internationalization in domestic research in this field, while also demonstrating that research in this area has gradually gained widespread attention and recognition within the international academic community.

4.1.2. Research Hotspots Focus on Keywords Such as “Chemoradiotherapy”, “Oral Mucositis”, and “Rehabilitation New Solution”

Keyword co-occurrence can reveal research hotspots, thematic clusters, and their evolution over time, enabling researchers to grasp the cutting edge of the field from a holistic perspective and identify important subfields [17]. Existing studies have shown that in cancer-related research on chemoradiotherapy—such as topics involving the side effects of chemotherapy/radiotherapy and the treatment of head and neck tumors—keywords like “chemoradiotherapy”, “survival”, and “prognosis” co-occur with core complications (including mucositis) in high-frequency networks, further illustrating the significant value of keyword co-occurrence analysis in revealing research focuses for specific populations and disease types, and holding great significance for understanding the distribution and evolution trends of research hotspots [27].

As one of the core methods in bibliometrics, keyword clustering analysis is widely applied in medical research to identify research hotspots and refine thematic structures. By constructing co-occurrence networks based on databases, this method divides research content into several thematic modules, thereby revealing the intrinsic relationships and evolutionary trends among these themes. This application logic has been elaborated upon in numerous bibliometric studies and methodological literature [17] [28] [29]. Based on this theoretical and methodological foundation, keyword cluster analysis further grouped “radiotherapy and chemotherapy”, “radiotherapy”, and “chemotherapy” under etiological research; “oral mucositis” and “stomatitis” around the symptoms themselves; “nasopharyn-

geal carcinoma” and “leukemia” targeting specific tumor populations; “nursing” focusing on clinical nursing strategies; and “Rehabilitation New Solution” focusing on drug interventions. These clusters complement one another, collectively forming a network of research hotspots in this field.

The emergence analysis further reveals the dynamic characteristics of research hotspots in this field, clearly reflecting the evolution of these trends over time and providing a crucial basis for identifying research frontiers. Among these, “oral mucositis” has long served as a core emerging term, indicating that this condition remains a key focus in research on complications of radiotherapy and chemotherapy. Meanwhile, “head and neck tumors” and “radiotherapy” have exhibited high emergence intensity and rapid emergence rates in the past two years. This is closely related to the clinical characteristics of head and neck tumors, where oral mucositis has a high incidence and poses significant risks following radiotherapy and chemotherapy, demonstrating the close alignment between research hotspots and the clinical characteristics of disease onset as well as clinical needs. These analytical conclusions are further supported by relevant bibliometric studies. Since 2019, mucosal damage associated with cancer treatment (including radiotherapy- and chemotherapy-induced OM) has exhibited a significant “emergence” trend in terms of citations and attention within the global research literature, suggesting that topics such as etiology, mechanisms, and interventions have become focal points of research [30]. The latest meta-analysis on OM following radiotherapy for head and neck tumors demonstrates a close association between treatment factors such as radiotherapy and chemotherapy and the risk of OM, further illustrating that the emergence of “head and neck tumors” and “radiotherapy” as recent research hotspots is closely aligned with clinical characteristics [31]. Taken together, these results from the emerging keyword analysis not only reflect the continuity of the core focus in OM research but also reveal a dynamic shift in recent research priorities toward radiation-induced oral mucositis associated with head and neck cancer.

4.1.3. Research Efforts are Primarily Led by University-Affiliated Hospitals, and Author Collaboration Networks Remain Loose

Institutional analysis shows that institutions with a higher number of publications include Beijing University of Chinese Medicine (8 papers), Sun Yat-sen University Cancer Center (6 papers), Zhejiang University of Traditional Chinese Medicine (5 papers), and Jiangxi Provincial Cancer Hospital (4 papers). These institutions are primarily university-affiliated hospitals and specialized cancer hospitals, reflecting a strong integration of clinical practice and research. Co-occurrence analysis of authors reveals that Jia Liqun, Gao Liying, Liu Yunxia, Gu Yanxiang, and Liu Jianhong have relatively high publication frequencies. However, the overall density of the author collaboration network is low (network density: 0.0005), indicating that collaboration among research teams remains insufficient, and there is significant room for growth in cross-institutional and cross-regional collaborative research. Consequently, it is evident that current research efforts are highly

concentrated in university-affiliated hospitals and comprehensive medical research institutions; however, the level of research collaboration between institutions and among authors remains generally low, and a tightly integrated, highly efficient collaborative research network has not yet been established. For example, bibliometric analysis of China's "research-oriented hospitals" reveals that while some institutions have high output, overall collaboration density is low, indicating that research collaboration still has room for improvement [32]. Moreover, bibliometric studies in similar fields have utilized visualized collaboration networks to reveal inter-institutional relationships, providing methodological references for understanding research collaboration patterns and disciplinary development, and highlighting the importance of in-depth network analysis in specific medical research fields [33]. Additionally, a bibliometric analysis of the medical collaboration network between China and ASEAN countries indicates that the scale of cooperation and the scope of participation are limited; this trend also reflects the widespread phenomenon that connections among research collaboration entities have not yet been fully expanded [34].

4.2. Analysis of the Current Status of Chemotherapy- and Radiation Therapy-Related Oral Mucositis Abroad

4.2.1. Research Interest Continues to Rise; China Leads in Publication Volume, But Needs to Improve Its Centrality

The national collaboration network shows that China ranks first with 194 publications, followed closely by the United States (139), Japan (86), and Brazil (74). Centrality analysis reveals that the United States (0.38), Italy (0.26), and England (0.23) exhibit high intermediary centrality, indicating they play crucial hub roles in international collaboration. Although China leads in publication volume, its centrality is only 0.07, suggesting that its bridging role within the international collaboration network is not yet prominent, and there is room for improvement in research influence. For example, in a bibliometric analysis of highly cited literature on oral cancer and related treatments, the United States demonstrated significantly higher publication output and a stronger role as a collaborative hub compared to China and other countries, indicating higher intermediary centrality in collaboration, whereas China, despite its large number of publications, exhibited relatively weaker collaboration density [27]. Similarly, in an analysis of the interdisciplinary field of oral microbiology and oncology, both the United States and China were major contributors, but the United States had tighter international collaborative connections [35]; Furthermore, in a broader bibliometric analysis of the field of cancer rehabilitation, both the United States and China are major contributors; however, the United States exhibits a more pronounced centrality and collaboration density within international collaboration networks. This suggests that a high publication volume does not necessarily correspond to greater international collaborative influence, a finding consistent with the lower centrality observed for China in this study [36].

4.2.2. Research Focuses on “Oral Mucositis”, “Head and Neck Cancer”, “Radiation Therapy”, and “Quality of Life”

Co-occurrence analysis of keywords revealed that “oral mucositis”, “head and neck cancer”, “radiation therapy”, “nasopharyngeal carcinoma”, and “quality of life” were high-frequency keywords, collectively forming the core research themes in the field of radiation- and chemotherapy-related oral mucositis. Cluster analysis divided the existing research into 10 clusters, primarily covering the basic pathogenesis of oral mucositis (#0 oral mucositis), clinical interventions (#2 low-level laser, #5 drug therapy), risk factors and management of complications (#8 risk factors), and emerging directions such as the oral microbiome (#6 oral microbiota). Word emergence analysis further reveals that “radiation-induced oral mucositis”, “nasopharyngeal carcinoma”, “risk factors”, and “oral microbiota” represent recent research frontiers, indicating that the field is gradually expanding beyond traditional symptom management toward in-depth exploration of pathogenesis, personalized risk prediction, and microbiome regulation. Results from existing meta-analyses show that the overall prevalence of oral mucositis in head and neck cancer patients following radiotherapy reaches as high as 94%, with its severity closely associated with chemotherapy regimens, lifestyle behaviors, and other risk factors. This fully highlights the practical necessity of focusing on radiotherapy-related complications in clinical research [32]. Furthermore, prospective cohort studies have confirmed that as radiotherapy progresses, worsening symptoms of oral mucositis significantly reduce patients’ health-related quality of life, particularly in terms of social interaction, eating, taste function, and dry mouth, further validating the significant research value of “quality of life” in this field [37]. Evidence regarding the management of radiation-induced oral mucositis indicates that multidisciplinary comprehensive interventions, basic oral care, symptom support, and pain management are current core research directions, aligning closely with themes such as “clinical intervention” and “symptom management” in this study’s clustering [5]. Meanwhile, recent systematic reviews have pointed out that oral microbiome dysbiosis is one of the key mechanisms underlying the onset and progression of head and neck radiotherapy complications, with changes in the oral microbiome being closely associated with mucosal damage [38]. A meta-analysis of oral mucositis prevention strategies has also found that microbiome interventions, such as probiotics, may offer potential benefits in alleviating radiotherapy- and chemotherapy-induced oral mucositis, suggesting that research focus is increasingly shifting toward elucidating mechanisms and targeted regulation of the microbiome [39].

4.2.3. High-Impact Publications Lay the Theoretical Foundation, While Research Institutions and Authors Exhibit a Multicenter Collaborative Pattern

Citation network analysis reveals that the most frequently cited publications include those by Elad S (2020, 121 citations), Pulito C (2020, 68 citations), Lalla RV (2014, 57 citations), and Elad S (2022, 47 citations), among others. These high-impact publications primarily focus on the MASCC/ISOO clinical practice guide-

lines, the pathophysiological mechanisms of oral mucositis, and advances in its treatment, thereby establishing the theoretical and practical foundations for oral mucositis research. The latest updates to the guidelines for the assessment and management of oral mucositis further emphasize the importance of standardized assessment criteria, which help enhance research consistency and clinical comparability [40] [41]. Cluster analysis of co-cited literature further categorized the research content into 10 clusters, covering topics such as “zinc sulfate”, “palifermin”, “probiotics”, “honey”, and “photo biomodulation”, clearly reflecting the trend toward diversified intervention methods in the field. This trend aligns closely with the findings of existing systematic reviews and meta-analyses: interventions for radiotherapy- and chemotherapy-induced oral mucositis are diverse, including photo biomodulation, cryotherapy, probiotics, and natural products, and these strategies are gaining increasing evidence-based support for alleviating symptoms and improving patients’ functional status and quality of life [42]. Among these, photo-biomodulation, as an important non-invasive intervention, has been systematically validated for its effectiveness in reducing the severity and pain of radiation and chemotherapy-induced oral mucositis, highlighting the high research value of this topic in the cluster analysis [43]. In the area of microbiome and natural interventions, a meta-analysis of probiotic interventions has also confirmed that they can significantly reduce the incidence of severe oral mucositis. This is highly consistent with research trends on the mechanisms of action of the oral microbiome and confirms the significance of “probiotics” as a key research direction within the cluster [44]; Meanwhile, natural interventions such as honey have demonstrated good potential in alleviating symptoms of oral mucositis and improving patients’ quality of life, aligning with the research value of the “honey” cluster theme [45]. Furthermore, meta-analyses of mucosal damage induced by cancer therapies have revealed trends in the evolution of research themes over time, further confirming the core focus areas of oral mucositis research and the strategic layout of cross-intervention approaches. Concurrently, research on mechanisms and models continues to push the boundaries of the field; for instance, the development of predictive models for severe oral mucositis induced by radiotherapy suggests that researchers are delving deeper into mechanism elucidation and risk prediction [46].

Among research institutions, the top publishers include Harvard University (23 papers), Brigham & Women’s Hospital (20 papers), Sichuan University (17 papers), and the Dana-Farber Cancer Institute (15 papers), reflecting a landscape in which institutions from China and the United States are neck and neck, jointly leading research in this field. Analysis of the author collaboration network reveals that Bossi P, Brzozowska A, Homa-Mlak I, Anderson CM, Tian X, and others have a high publication frequency and represent the core research forces in the field. However, the overall density of the author collaboration network is relatively low (0.0016), suggesting that collaboration among the core author group is not yet close. There is still significant room for growth in cross-team and cross-national

collaborative research. In the future, it will be necessary to further strengthen international and inter-team cooperation and coordination to drive the field's research toward deeper and broader development. For example, large-scale meta-analyses have also revealed the collaborative network patterns and knowledge structures in research on mucosal damage caused by cancer treatments. Such studies utilize CiteSpace and VOS Viewer to visualize collaborative relationships between institutions and countries, aiding in the understanding of the global distribution of OM research capabilities and thematic focus [30]. Concurrently, research from institutions such as Brigham & Women's Hospital, Dana-Farber, and Harvard emphasizes the value of precision medicine in OM risk prediction, highlighting the central role of European and American institutions in high-impact mechanistic and predictive research [47]. Recent reviews also indicate that research on management strategies is further integrating global evidence to improve the prevention and treatment of OM, while promoting cross-institutional collaboration to standardize research processes [48]. Furthermore, the latest systematic reviews and meta-analyses have increasingly focused on the identification of CIOM risk factors and clinical translation research, highlighting a shift in research priorities from basic description toward precise prediction and intervention strategies [49].

4.3. Comparison and Implications of Radiotherapy- and Chemotherapy-Induced Oral Mucositis in China and Abroad

Radiotherapy- and chemotherapy-induced OM is a common and frequently occurring complication in the field of supportive cancer care worldwide. Significant differences exist between China and other countries in terms of guideline systems, preventive interventions, clinical management, and research directions. These differences not only reflect variations in the allocation of medical resources and clinical practice models but also provide important references and insights for optimizing the diagnosis and treatment pathways for oral mucositis in China.

Internationally, authoritative evidence-based guidelines such as those from MASCC/ISOO and ESMO serve as the core framework. Through Delphi expert consensus, these guidelines have established unified OM assessment criteria, emphasizing evidence-based interventions such as basic oral care, pain management, and infection control [41]. The ESMO Interactive Clinical Practice Guidelines further highlight the concept of integrated, full-process management—combining staging assessment, prevention, and treatment—to collectively establish a closed-loop management system encompassing “preoperative oral assessment—low-level laser therapy (LLLT)—standardized analgesia and infection control”. International clinical practice generally features clear levels of evidence for interventions, mature multidisciplinary collaboration models, and a strong emphasis on large-scale real-world studies and the development of precise risk prediction models. It also leads in the clinical translation and application of cutting-edge technologies such as biologics and phototherapy.

In China, organizations such as the Chinese Stoma to logical Association and the Chinese Society of Clinical Oncology (CSCO) have successively released relevant expert consensus documents. In particular, the “2025 Chinese Expert Consensus: Prevention and Treatment of Radiation- and Chemotherapy-Induced Oral Mucositis”, building upon the core strategies of international guidelines, incorporates traditional Chinese medicine (TCM) elements tailored to the characteristics of the Chinese population and clinical realities, thereby establishing a treatment protocol with distinct local characteristics [4]. However, overall, domestic clinical practice still primarily relies on symptomatic and supportive treatment. The implementation of primary prevention remains insufficient, multidisciplinary collaboration mechanisms are not yet fully developed, and there is a relative lack of large-scale, multicenter cohort studies and long-term follow-up on prognosis. Furthermore, the level of standardized diagnosis and treatment implementation in primary healthcare institutions still needs to be improved.

A comprehensive comparison reveals that the strengths of international diagnostic and treatment systems lie in their unified assessment criteria, robust evidence-based foundations for preventive interventions, highly standardized management processes, and well-established multidisciplinary collaboration; whereas the distinctive features of China’s system include the proven efficacy of traditional Chinese medicine interventions and the strong adaptability of treatment protocols to local conditions. Building on these existing gaps and strengths, China should, in the future, accelerate the development of a tiered, standardized diagnostic and treatment system for oral mucositis—based on the promotion of high-level evidence-based interventions such as low-level laser therapy—and incorporate pre-operative oral screening and standardized oral care into routine clinical procedures; At the same time, we should continue to deepen collaborative research between traditional Chinese and Western medicine, refine risk prediction models and efficacy evaluation systems suited to the physical constitution of the Chinese population, gradually narrow the gap in clinical practices among medical institutions at different levels, comprehensively enhance the standardization of prevention and control for radiation- and chemotherapy-related oral mucositis, ensure the smooth completion of radiation and chemotherapy regimens for cancer patients, and improve their quality of life.

5. Conclusion

This study employs bibliometrics and visualization analysis to examine trends in domestic and international research on radiotherapy- and chemotherapy-related oral mucositis since 2000, providing insights for the discipline’s development and future research. Domestic research has seen rising interest and a marked trend toward internationalization, focusing on clinical care and pharmacological interventions. Recently, it has expanded to include head and neck cancers and precision interventions. While university-affiliated hospitals are the primary research entities, collaboration among authors remains insufficient. International research

continues to deepen; although China ranks first globally in the number of publications, the centrality of international collaboration needs to be enhanced. Research hotspots are shifting toward exploring mechanisms, and multicenter, multidisciplinary collaboration represents the future direction.

Guidelines and Standards Statement

This study follows the BIBLIO: Guideline for Reporting Bibliometric Reviews of the Biomedical Literature to enhance the transparency and reproducibility of bibliometric reviews [50]. The study was structured in accordance with the BIBLIO reporting items across the title, abstract, introduction, methods, results, and discussion sections.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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