Original Article

A dynamic study of the postoperative management of thyroid cancer from 2003 to 2022: a bibliometric analysis

Xi Yang[1], Yiming Wang[2], Yunpeng Luo[1], Teng Guo[1], Guangde Zhang[3]

[1]Graduate School, Beijing University of Chinese Medicine, Beijing, China; [2]Graduate School, China Academy of Chinese Medical Sciences, Beijing, China; [3]Department of Endocrinology, Xiyuan Hospital, China Academy of Chinese Medical Sciences, Beijing, China

Contributions: (I) Conception and design: X Yang, G Zhang; (II) Administrative support: None; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: X Yang, T Guo; (V) Data analysis and interpretation: X Yang, Y Wang; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Guangde Zhang, MM. Department of Endocrinology, Xiyuan Hospital, China Academy of Chinese Medical Sciences, No. 1 Xiyuan Playground, Haidian District, Beijing 100091, China. Email: zgd641101@126.com.

Background: Over the past 20 years, the global incidence of thyroid cancer has continued to increase. The volume of literature on the postoperative management of thyroid cancer comprises 1,040 articles, from 64 countries, with 1,400 journals publishing the relevant literature, and several guidelines on the treatment of thyroid cancer. This study used bibliometric methods to identify research hotspots and explore future directions in this field.

Methods: We comprehensively searched the Science Citation Index Expanded (SCI-E) database of the Web of Science Core Collection (WOSCC) for articles published from 2003 to 2022 on the postoperative management of thyroid cancer. Using CiteSpace 6.1.R6 and Microsoft Office Excel 2010, we evaluated and visualized the search results. Using R Studio, we generated a network of spatial geographic distribution maps and cooperative network.

Results: A total of 1,040 publications were included in the study. The results revealed an overall upward trend in the number of publications and citations over the past 20 years. The United States of America (USA) had the largest number of publications and the highest centrality (n=282, centrality =0.28). Johns Hopkins University had highest centrality (centrality =0.15) and was the academic center of the field. *Thyroid* was the journal with the highest number of citations (n=826), and the *American Journal of Surgical Pathology* was the journal with the highest centrality (centrality =0.08). The top 10 citations in the literature were mainly guidelines and consensus statements on the management of thyroid cancer. A keyword-based clustering analysis revealed the prominence of clusters of keywords, such as follow-up, recurrent laryngeal nerve, and medullary thyroid carcinoma (MTC). A keyword burst detection analysis showed that the term papillary had the highest burst intensity (strength =8.02), while management guidelines, association guidelines, active surveillance (AS), microcarcinoma, and differentiated thyroid cancer were the current burst words.

Conclusions: Over the past two decades, the number of relevant publications in the postoperative management of thyroid cancer field has continued to grow. Among the many research directions, follow-up, recurrent laryngeal nerve, and MTC are research hotspots. Future research is likely to revolve around guidelines and consensus statements on the management of thyroid cancer, AS, and microcarcinoma in differentiated thyroid cancer.

Keywords: Postoperative management; thyroid cancer; bibliometric analysis

Submitted May 20, 2023. Accepted for publication Sep 22, 2023. Published online Nov 14, 2023.
doi: 10.21037/gs-23-218
View this article at: https://dx.doi.org/10.21037/gs-23-218

Introduction

In recent years, the global incidence of thyroid cancer has continued to increase, with age-standardized incidence rates of 3.1 and 10.1 cases per 100,000 people for men and women in 2020, respectively (1). Conversely, the thyroid cancer mortality rates for men and women have remained stable or even declined in most countries (1). The increase in the incidence of thyroid cancer is primarily due to the increased detection of indolent papillary thyroid cancer (PTC) rather than the rare but highly aggressive follicular, medullary, and anaplastic thyroid cancer (2). Thyroid surgery is one of the main treatments for thyroid cancer (3), and while technical approaches, such as the intraoperative neuromonitoring (IONM) of the recurrent laryngeal nerve, intraoperative indocyanine green fluorescence angiography, and autofluorescence of the parathyroid glands, have been introduced, permanent recurrent laryngeal nerve palsies and permanent hypoparathyroidism are still reported in 0.3–3% and in 1–4% of cases, respectively (4-8). The surgical management of thyroid cancer has shifted from a one-size-fits-all approach to an individualized, risk-tailored treatment and management strategy (9). The postoperative management of thyroid cancer, including the prevention and treatment of postoperative complications, the assessment of the postoperative risk of recurrence, adjuvant therapy, thyroid hormone replacement therapy, and the long-term monitoring of recurrence or metastasis, is an important part of any individualized treatment plan and is significant in optimizing the clinical outcome and quality of life of patients (10-12).

Bibliometrics is the study of the quantitative analysis of literature related to a specific topic using mathematical and statistical methods (13,14). A bibliometric analysis involves research content, such as countries, institutions, journals, authors, keywords, and references (15), which can clearly and visually show the research results and trends in a particular field (16,17). At present, few bibliometric analyses have been conducted on the postoperative management of thyroid cancer. Thus, this study conducted a bibliometric analysis of the literature related to the postoperative management of thyroid cancer from 2003 to 2022 to summarize the research hotspots in this field over the past 20 years, explore future development directions, and provide ideas for further exploration and innovation in this field.

Highlight box

Key findings

- Future research is likely to focus on guidelines and consensus statements on the management of thyroid cancer, active surveillance, and microcarcinoma in differentiated thyroid cancer.

What is known, and what is new?

- Over the past 20 years, 1,040 articles, from 64 countries, have been published on the postoperative management of thyroid cancer, with 1,400 journals publishing the relevant literature in this area and several guidelines on the treatment of thyroid cancer.
- Bibliometric methods were applied to identify research hotspots and explore future directions in the postoperative management of thyroid cancer field.

What is the implication, and what should change now?

- To achieve better outreach in postoperative thyroid cancer management research, we suggest that countries jointly conduct high-quality multicenter-related studies. To achieve optimal management, international guidelines on the postoperative management of patients with thyroid cancer are needed.

Methods

Data collection

A comprehensive search was conducted through the Science Citation Index Expanded (SCI-E) database in the Web of Science Core Collection (WOSCC). The search strategy was as follows: subject: ("postoperative management" AND "thyroid cancer"); period: January 1, 2003 to December 31, 2022; language: English; and document type: Article. All the literature data that met the criteria were downloaded and exported as a text file, including data on the title, author, abstract, institution, country, journal, keywords, and references. CiteSpace 6.1.R6 was used to remove duplicate documents. Articles that did not meet the criteria or that had been published as "proceedings papers", "editorial material", "letters", or "meeting abstracts" were excluded.

Data analysis

The bibliometric tool CiteSpace 6.1.R6 was selected for the bibliometric analysis and data visualization analysis, which included a country and institutional collaboration network analysis, journal co-citation and literature co-citation analysis, co-occurrence networks for keywords analysis, and keyword burst analysis. "Betweenness centrality" measures the number of times a node lies on the shortest path between other nodes. Nodes with high betweenness

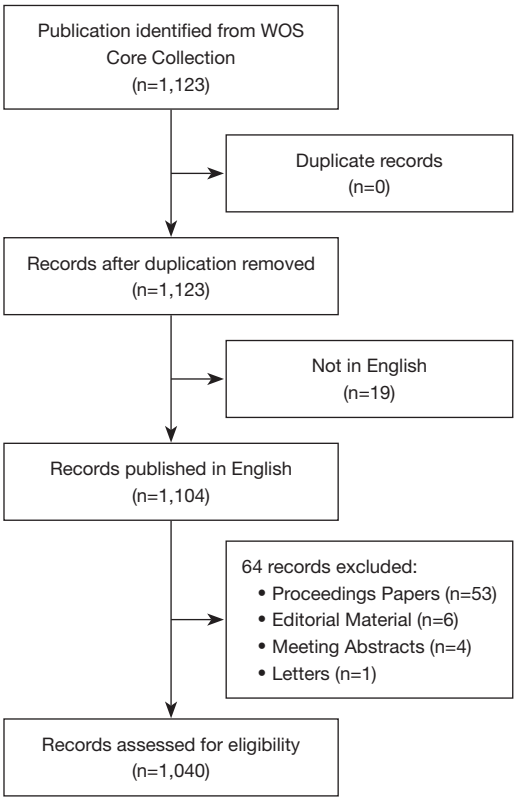


Figure 1 Study inclusion flow chart. WOS, Web of Science.

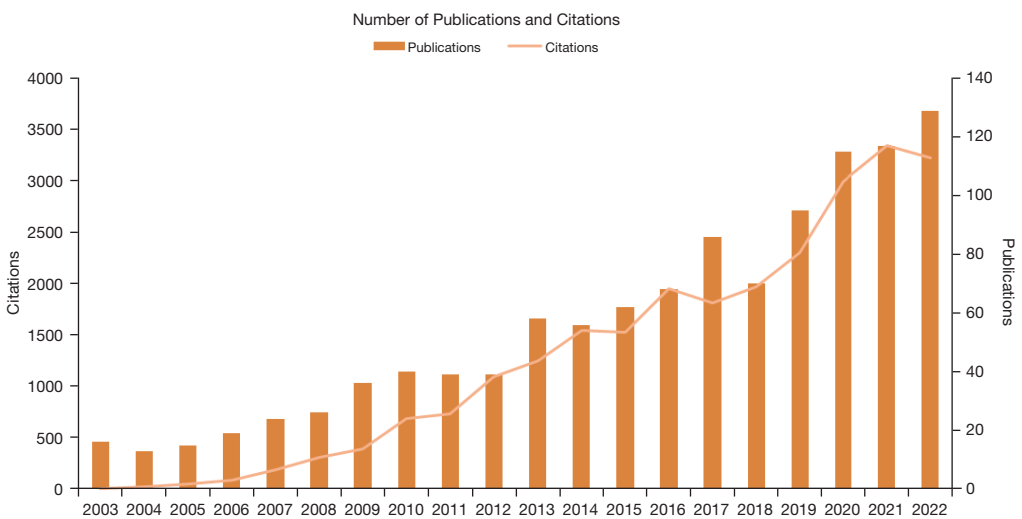
centrality are generally considered potential pivotal points (18). "Keyword bursts" indicate a specific period of abrupt change in keyword frequency, and burst detection algorithms for keywords are used to identify emerging research frontiers (18,19). Microsoft Office Excel 2010 was used to reflect the annual number of publications and their overall growth trends in citation counts. R studio was used to generate spatial geographic distribution maps and collaborative linkage networks.

Results

Ultimately, 1,040 publications were obtained for the visual analysis. *Figure 1* shows the inclusion flow chart for the study.

Trends in the number of annual publications and citations

Over the past 20 years, despite some slight decreases in specific years, the number of publications related to the postoperative management of thyroid cancer has shown an overall upward trend, as has the number of citations in the literature (*Figure 2*). The year 2022 had the highest number of publications (n=129), while the year 2004 had the lowest



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Publications	16	13	15	19	24	26	36	40	39	39	58	56	62	68	86	70	95	115	117	129
Citations	3	25	49	83	192	310	390	688	736	1095	1249	1549	1523	1954	1813	1970	2298	2991	3341	3224

Figure 2 Numbers of publications and citations from 2003 to 2022.

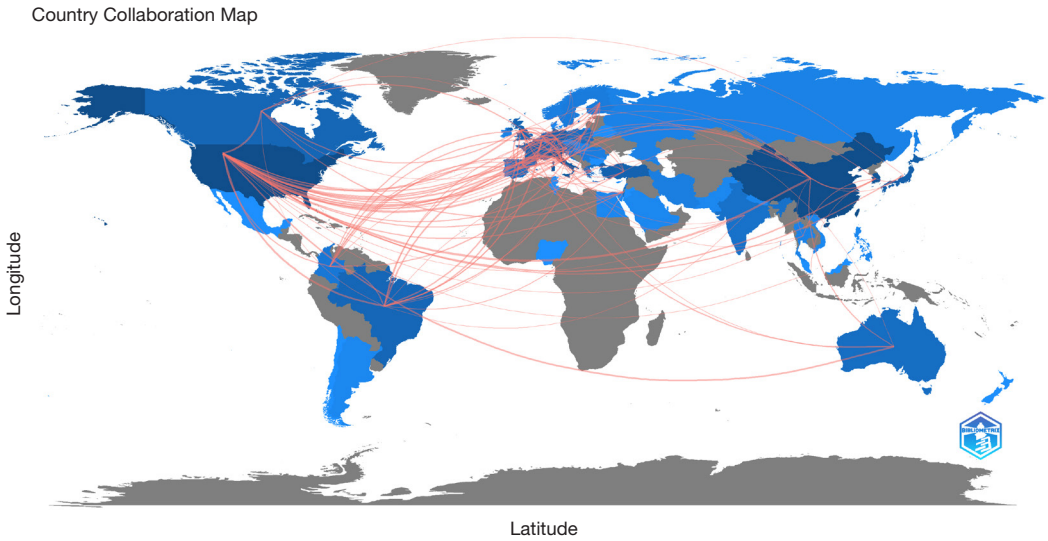


Figure 3 Cooperation network map.

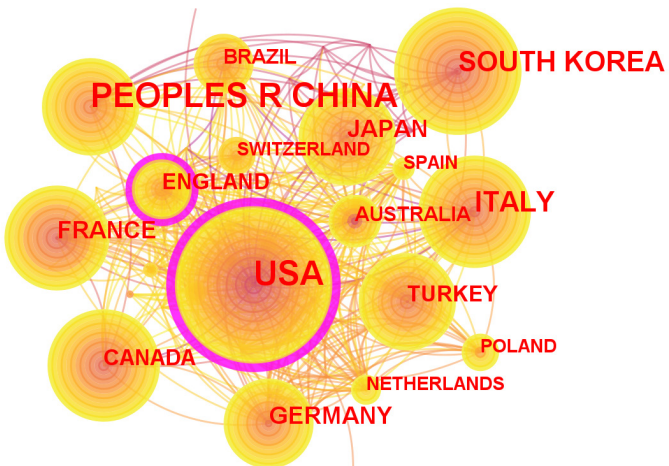


Figure 4 National cooperation network.

number of publications (n=13). The volume of literature in 2022 was approximately 10 times higher than that in 2004. The year 2021 had the highest number of citations (n=3,341).

National and institutional cooperation networks

In the last 20 years, a total of 64 countries and 1,400 institutions have published literature related to the postoperative management of thyroid cancer. As the collaboration network map shows, a high concentration of research on the postoperative management of thyroid cancer was conducted in North America, Asia and Europe, with frequent collaborations between North America and Europe (*Figure 3*). In terms of the number of publications, the United States of America (USA) had the highest number of publications (n=282), followed by China (n=245), and South Korea (n=117). The top 10 countries in terms of number of publications were mainly concentrated in North America and Asia; the two countries with the best centrality were the USA and England, of which the USA had the highest centrality (centrality =0.28) (*Figure 4*). Conversely, the top 10 countries in terms of centrality were mainly concentrated in North America and Europe (*Table 1*).

Table 1 Top 10 countries in terms of frequency and centrality

Rank	Frequency		Centrality	
	Country	Data	Country	Data
1	USA (North America)	282	USA (North America)	0.28
2	China (Asia)	245	England (Europe)	0.13
3	South Korea (Asia)	117	Italy (Europe)	0.08
4	Italy (Europe)	100	Australia (Oceania)	0.07
5	Japan (Asia)	57	India (Asia)	0.07
6	Turkey (Asia)	44	Spain (Europe)	0.06
7	France (Europe)	42	Netherlands (Europe)	0.05
8	Germany (Europe)	42	Germany (Europe)	0.04
9	Canada (North America)	32	France (Europe)	0.03
10	England (Europe)	31	Greece (Europe)	0.03

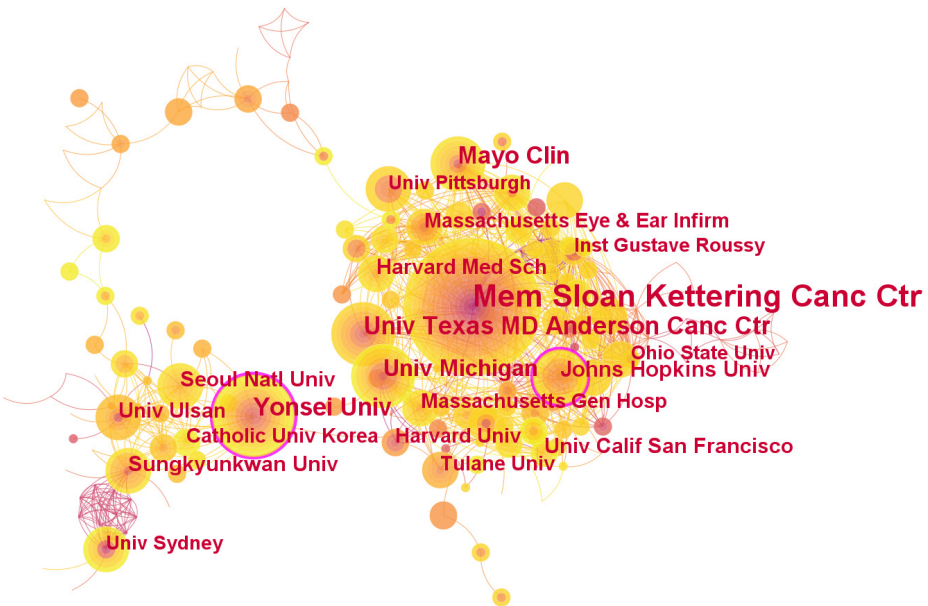


Figure 5 Institutional cooperation network.

As *Figure 5* and *Table 2* show, the institution with the highest number of publications was Memorial Sloan Kettering Cancer Center (n=52), which is located in the USA. The two institutions with the best centrality were Johns Hopkins University and Yonsei University, of which, Johns Hopkins University, which is located in the USA, had the best centrality (centrality =0.15). The network of national and institutional collaborations showed that the USA was the academic core of the field.

Cited journals

In the last 20 years, a total of 307 journals have published literature related to the postoperative management of thyroid cancer. Among them (*Table 3*), the most cited journal was *Thyroid* (n=826), which has a Journal Citation Reports (JCR) division of Q1 (Journals with top 25% impact factor). *Thyroid* is the official journal of the American Thyroid Association and is affiliated with the European

Table 2 Top 10 Institutions in terms of frequency and centrality

Rank	Frequency		Centrality	
	Institution	Data	Institution	Data
1	Mem Sloan Kettering Canc Ctr (USA)	52	Johns Hopkins Univ (USA)	0.15
2	Yonsei Univ (South Korea)	26	Yonsei Univ (South Korea)	0.14
3	Univ Texas MD Anderson Canc Ctr (USA)	25	Mem Sloan Kettering Canc Ctr (USA)	0.07
4	Mayo Clin (USA)	19	Inst Gustave Roussy (France)	0.07
5	Sichuan Univ (China)	16	Univ Sao Paulo (Brazil)	0.07
6	Sungkyunkwan Univ (South Korea)	15	Sungkyunkwan Univ (South Korea)	0.06
7	Johns Hopkins Univ (USA)	14	Univ Padua (Italy)	0.05
8	Seoul Natl Univ (South Korea)	14	Univ Pisa (Italy)	0.05
9	Univ Michigan (USA)	13	Mayo Clin (USA)	0.03
10	Univ Ulsan (South Korea)	13	Univ Paris 11 (France)	0.03

Table 3 Top 10 journals in terms of citations and centrality

Rank	Citations				Centrality			
	Journal	Citation counts	Journal citation reports	h-index	Journal	Centrality	Journal citation reports	h-index
1	*Thyroid*	826	Q1	126	*Am J Surg Pathol*	0.08	Q1	193
2	*J Clin Endocr Metab*	646	Q1	328	*Am J Clin Pathol*	0.07	Q1	117
3	*Surgery*	610	Q1	148	*Am J Otolaryng*	0.07	Q2	52
4	*World J Surg*	602	Q2	135	*Acta Cytol*	0.06	Q3	53
5	*Ann Surg*	425	Q1	284	*Surg Endosc*	0.06	Q2	141
6	*Ann Surg Oncol*	417	Q1	155	*Eur J Surg Oncol*	0.05	Q1	89
7	*Head Neck-J Sci Spec*	414	Q1	113	*Eur J Endocrinol*	0.05	Q1	131
8	*Laryngoscope*	355	Q2	134	*Lancet*	0.05	Q1	700
9	*Clin Endocrinol*	353	Q3	137	*Adv Anat Pathol*	0.04	Q2	69
10	*Eur J Endocrinol*	334	Q1	131	*Clin Oncol-UK*	0.04	Q2	68

h-index means that the journal has h articles that have been cited at least h times.

Thyroid Association and the Latin American Thyroid Society. The next most cited journals were the *Journal of Clinical Endocrinology and Metabolism* (n=646), and *Surgery* (n=610). The top 10 cited journals were related to the three areas of endocrinology and metabolism (n=4), surgery (n=4), and otolaryngology (n=2). The journal with the highest centrality (centrality =0.08) was the *American Journal of Surgical Pathology*, which has a JCR division of Q1 and which focuses on pathology and surgical research directions.

We further plotted the dual-map overlay of journals to show the relationship between the journals (*Figure 6*). The colored curves between the citation map on the left and the citation map on the right provide an understanding of the interdisciplinary relationships in the given field. Notably, publications in the medicine, medical and clinical (green track) fields were influenced by publications in the health, nursing and medicine fields (z=7.0675, f=88,426), and the molecular, biology and genetics fields (z=2.0904, f=28,291).

Publications with co-citations

In the last 20 years, the top 10 cited articles in this field (*Table 4*) were mainly guidelines and consensus statements on thyroid cancer management (n=7), and the

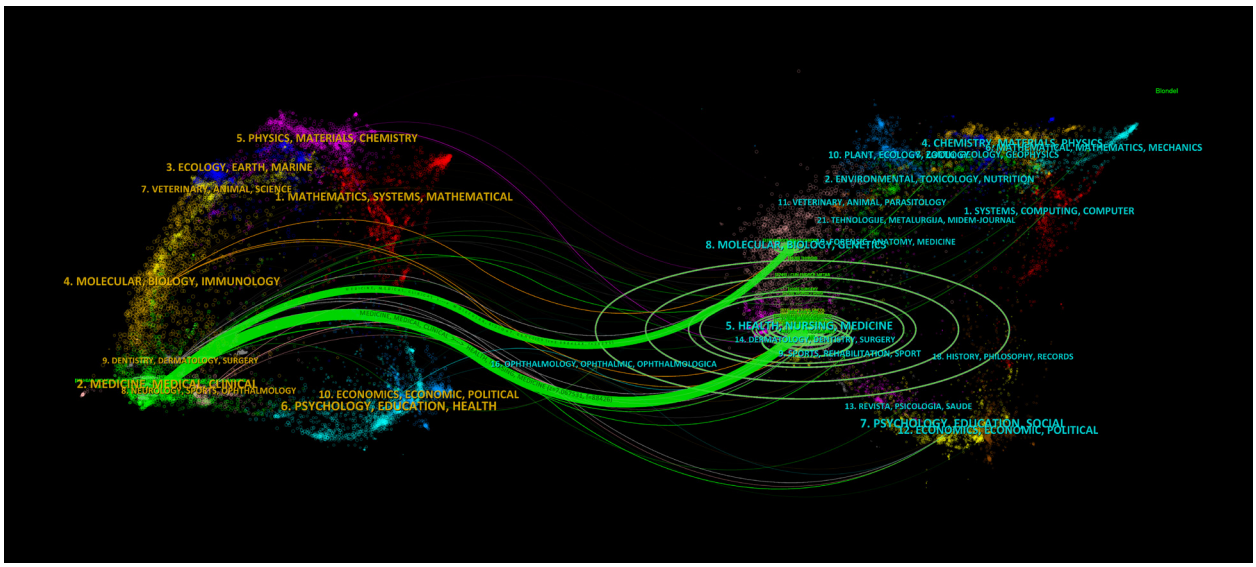


Figure 6 Dual-map overlay of journals.

Table 4 Top 10 classical publications in terms of co-citation frequency

Rank	Citation counts	Author	Year	Title	Journal
1	274	Haugen BR	2016	2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer (20)	*Thyroid*
2	89	Cooper DS	2009	Revised American Thyroid Association Management Guidelines for Patients with Thyroid Nodules and Differentiated Thyroid Cancer (21)	*Thyroid*
3	57	Cooper DS	2006	Management Guidelines for Patients with Thyroid Nodules and Differentiated Thyroid Cancer (22)	*Thyroid*
4	40	Perros P	2014	Guidelines for the Management of Thyroid Cancer (23)	*Clin Endocrinol*
5	39	Lim H	2017	Trends in Thyroid Cancer Incidence and Mortality in the United States, 1974-2013 (24)	*JAMA*
6	31	Pacini F	2006	European Consensus for the Management of Patients with Differentiated Thyroid Carcinoma of the Follicular Epithelium (25)	*Eur J Endocrinol*
7	30	Wells SA	2015	Revised American Thyroid Association Guidelines for the Management of Medullary Thyroid Carcinoma (26)	*Thyroid*
8	27	Francis GL	2015	Management Guidelines for Children with Thyroid Nodules and Differentiated Thyroid Cancer (27)	*Thyroid*
9	23	Randolph GW	2012	The Prognostic Significance of Nodal Metastases from Papillary Thyroid Carcinoma can be Stratified based on the Size and Number of Metastatic Lymph Nodes, as well as the Presence of Extranodal Extension (28)	*Thyroid*
10	21	Adam MA	2017	Is There a Minimum Number of Thyroidectomies a Surgeon Should Perform to Optimize Patient Outcomes? (29)	*Ann Surg*

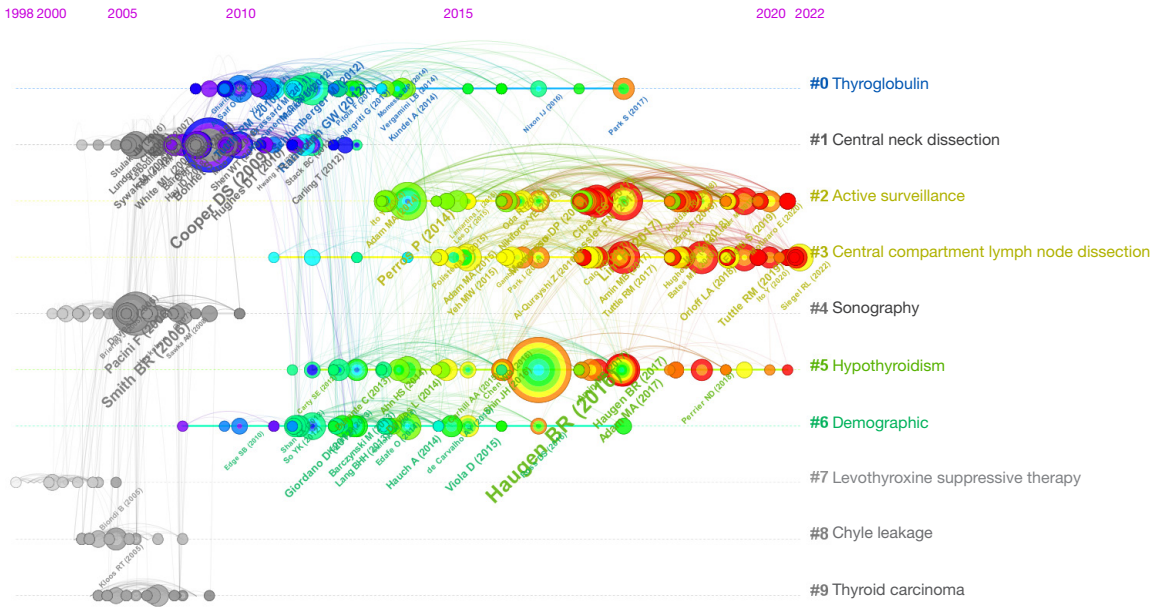


Figure 7 Publications with co-citation timeline.

epidemiology of thyroid cancer (n=1), and studies related to the postoperative prognosis of thyroid cancer (n=2). The number one article on guidelines for the management of thyroid nodules and differentiated thyroid cancer in adults was written by Haugen *et al.* (20), and published in the *Thyroid* journal in 2016. The article made recommendations on the long-term management of differentiated thyroid cancer after surgery, including thyroid stimulating hormone (TSH) suppressive therapy, the monitoring of differentiated thyroid carcinoma (DTC) recurrence using ultrasound (US) and other imaging techniques [e.g., US, radioiodine-131 (RAI) single-photon emission computed tomography-computed tomography (SPECT/CT), X-ray computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography-CT (PET-CT)], serum thyroglobulin (Tg), and the comprehensive treatment and management of recurrent or metastatic DTC.

By analyzing the timeline of co-cited publications (*Figure 7*), an understanding was gained of the distribution of the research themes in the cited literature and their evolution over time. Before 2010, the main research topics in this field were "levothyroxine suppressive therapy", "chyle leakage", "thyroid carcinoma", "sonography", and "central neck dissection". However, over time, in the 5 years from 2010 to 2015, the research topics in this field focused on "thyroglobulin", and "demographic". In recent years, the research topics have focused on "hypothyroidism", "central compartment lymph node dissection", and "active surveillance".

The co-occurrence and clustering of keywords

To reduce bias in the automated bibliometric analysis in Citespace, we manually merged the keywords "cancer" and "carcinoma". Subsequently, a total of 551 keywords and 27 keyword clusters were found (*Figures 8*,*9*). The top 10 keywords were "cancer" (n=627), "management" (n=574), "surgery" (n=156), "thyroid cancer" (n=144), "nodule" (n=118), "recurrence" (n=108), "prognostic factor" (n=101), "therapy" (n=101), "follow-up" (n=88), and "papillary" (n=86). The top three keyword clusters were follow-up (#0), recurrent laryngeal nerve (#1), and medullary thyroid carcinoma (MTC) (#2).

Burst detection of keywords

Through keyword burst detection, we identified the top 20 burst words about the postoperative management of thyroid cancer in the last 20 years (*Figure 10*). In terms of burst intensity, the top three keywords were "papillary" (strength =8.02), "management guideline" (strength =7.31), and "postoperative thyroglobulin level" (strength =6.66). In chronological order, the main early burst words were "prognostic factor", "papillary", "follow-up",

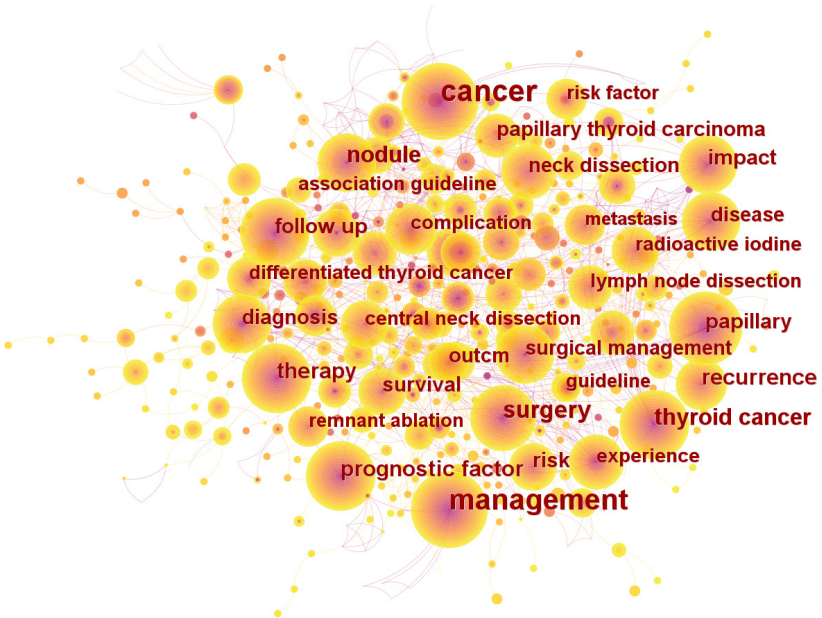


Figure 8 Keyword co-occurrence map.

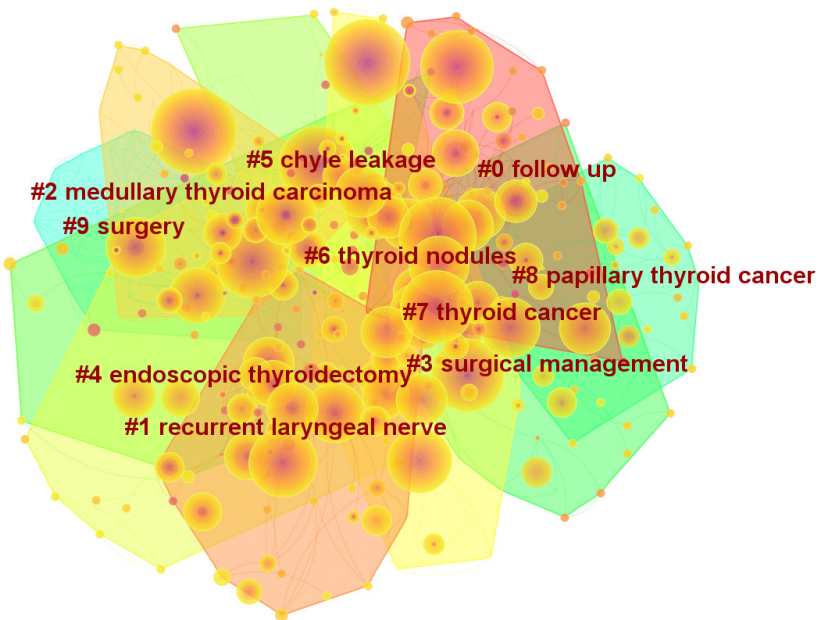


Figure 9 Keyword clustering map.

and "positron emission tomography". Subsequently, the terms "preoperative ultrasonography", "needle aspiration biopsy", and "surgical management" emerged as keywords for preoperative assessment tools and surgical treatment. Next, words related to thyroid cancer metastasis, such as "metastasis", "postoperative thyroglobulin level", "lymph node dissection" and "lymph node", emerged. In recent years, the words "management guideline", "association guideline" and "active surveillance" have emerged, and terms related to the pathological classification of thyroid

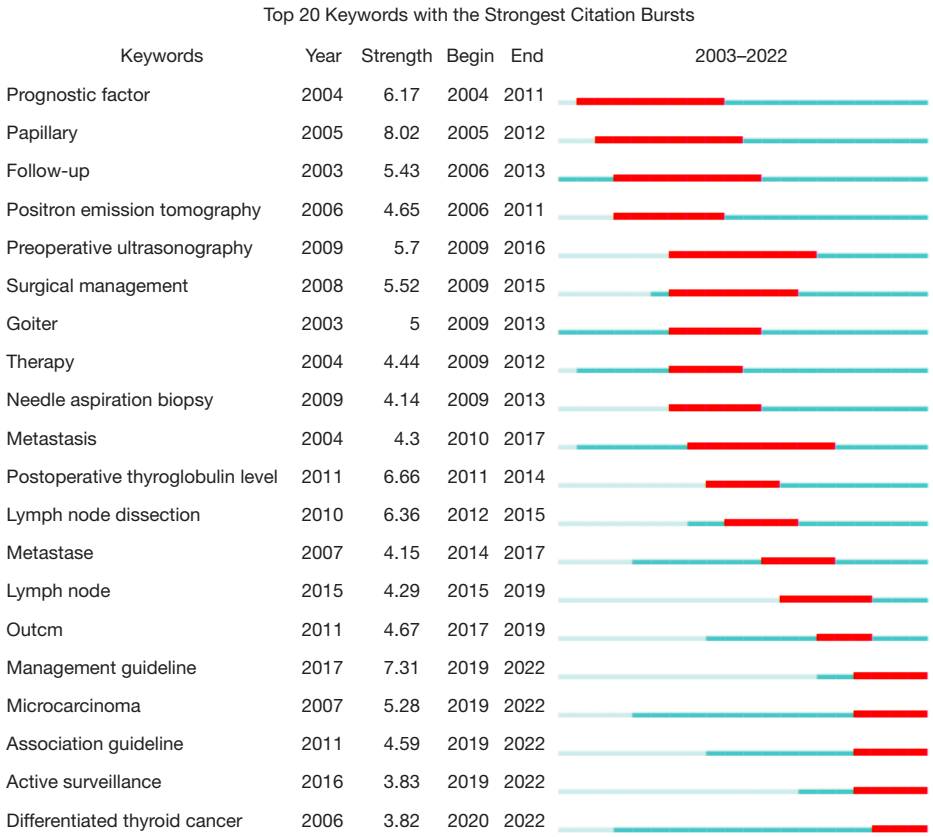


Figure 10 Top 20 keywords with the strongest citation bursts.

cancer, such as "microcarcinoma" and "differentiated thyroid cancer", once again became burst words.

Discussion

General information

The number of publications related to the postoperative management of thyroid cancer and its citations generally showed an increasing trend over the past 20 years, indicating a gradual increase in academic focus in this area, and the possibility that more research will be conducted in the future. Johns Hopkins University showed the highest centrality (centrality =0.15) and was the academic center of the field. Collaboration between North American and European countries in this research area was frequent, while Asian countries had a high number of publications but lacked collaborations with other countries. None of the four Asian countries (i.e., China, South Korea, Japan, and Turkey) that were in the top 10 in terms of the number of publications showed close cooperation or obvious centrality with other countries. This result may be related to the differences in economic power and the medical levels of different countries. There were direct or indirect collaborations between different institutions, but these institutions tended to engage in more collaborations within their own countries. Institutions in the USA published the highest number of publications, which was consistent with the national collaboration networks. In the top 10 institutions in terms of frequency, five institutions were located in Asia, with Korean institutions accounting for 80%. Yonsei University in South Korea showed better centrality (centrality =0.14) than other institutions in Asia. This may be related to the high incidence of thyroid cancer in South Korea. A global epidemiological survey on thyroid cancer in 2020 found that the incidence rate of thyroid cancer in females in South Korea was 45 cases per 100,000 people, and that South Korea had the highest incidence-to-mortality ratio for both sexes (2). To ensure better outreach in postoperative thyroid cancer management research, we suggest that countries and institutions with

close collaborative relationships continue to maintain close academic exchanges while establishing academic ties with less collaborative countries and institutions to jointly conduct high-quality multicenter-related studies and promote the globalization of postoperative thyroid cancer management research.

For the past 20 years, *Thyroid* has been the most cited journal for literature related to the postoperative management of thyroid cancer, and the *American Journal of Surgical Pathology* has been the highest centrality in publishing research related to the postoperative management of thyroid cancer. These journals cover the areas of endocrinology and metabolism, pathology, and surgery. These results suggest that cellular-level features of thyroid cancer and strategies for the perioperative management of thyroid cancer remain major areas of interest, and that future advances and breakthroughs are likely to come from these areas of research. The "2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer" were published in the *Thyroid* journal by Haugen *et al.* in 2016 (20), and this literature was the most cited article in the field for almost 20 years, but these guidelines are now outdated. We look forward to the guidelines being updated, and we note that there is a need for international guidelines on the postoperative management of patients with thyroid cancer if more optimal management is to be achieved.

The hotspots and frontiers

Our keyword co-occurrence and clustering analysis, and literature co-citation timeline graphs revealed that the research hotspots for the postoperative management of thyroid cancer in the past 20 years could be summarized into the following four topics: pathological classification, surgical strategy, postoperative complications, and postoperative follow-up. These four topics include preoperative and intraoperative issues, and thus show that preoperative and intraoperative management influence postoperative treatment.

The keyword-based clustering analysis revealed the prominence of clusters such as follow-up, recurrent laryngeal nerve, and MTC. The postoperative follow-up of thyroid cancer should be surveillance-oriented, and the proactive monitoring of thyroid cancer recurrence and metastasis is the focus of postoperative management (12). First, stratification according to the stage of thyroid cancer and risk of recurrence facilitates the selection of the most appropriate postoperative management strategy. The risk of recurrence is associated with the number and size of metastatic cumulative lymph nodes, and the presence of extranodal spread, the pathological classification of the thyroid cancer, the location and size of the tumor, and the presence of peritumoral or vascular infiltration (30). Second, current studies have shown that serum Tg levels have a high sensitivity and specificity in detecting the recurrence and metastasis of thyroid cancer (31,32). However, the optimal threshold to predict disease recurrence based on postoperative serum Tg levels has yet to be determined. A 2020 cohort study showed that an early postoperative Tg level <2 ng/mL could be used as a threshold to guide adjuvant therapy and determine the frequency of long-term monitoring (33). Other studies have shown that even with a Tg level <1 ng/mL, ^{131}I radioiodine whole-body imaging (^{131}I-WBS) still detects the functional remnants of thyroid tissue, suggesting the possibility of tumor recurrence, and that Tg may not be able to identify tumor metastases of smaller sizes (34,35). Serum Tg level monitoring combined with imaging techniques (e.g., US, RAI SPECT/CT, CT, MRI, and PET-CT) is an effective tool for determining the recurrence and metastasis of thyroid cancer after surgery, and it can be used to help to dynamically assess the risk of recurrence and death (36).

The recognition and management of postoperative thyroid cancer complications are an integral part of postoperative thyroid cancer management. Return laryngeal nerve (RLN) injury is a common complication after thyroidectomy (37,38). It has been reported that the incidence of permanent postoperative RLN injury is 0.3–3%, and the incidence of temporary RLN injury is 3–8.9% (4,5,39). Risk factors for postoperative RLN injury include reoperation, the type of surgery, malignancy, and tumor size, and some studies have shown a higher risk of vocal cord dyskinesia in patients who undergo central neck dissection or have larger tumors (4,5). Other studies have reported that there is no increased risk if central neck dissection is performed by high-volume surgeons (40). IONM could be used to prevent RLN injury. IONM uses vocal cord electromyography to monitor the electrophysiologic activity of the RLN, which can help identify anatomical changes in the RLN during thyroidectomy (41,42). However, several studies have shown (43-45) that IONM fails to significantly reduce the incidence of intraoperative RLN injury compared to conventional RLN visualization.

MTC is a rare and aggressive neuroendocrine carcinoma that accounts for approximately 1–2% of all thyroid

cancers, and 15% of thyroid cancer-related deaths, and has a poor prognosis (26,46). Early surgery with complete tumor resection has the potential to cure MTC, and the postoperative monitoring of serum calcitonin and carcinoembryonic antigen levels is essential (47). Nevertheless, the management of advanced, progressive MTC remains challenging and is currently dominated by targeted therapies with tyrosine kinase inhibitors (TKIs) (48,49); however, further research still needs to be conducted on TKI resistance and the adverse effects of TKIs to improve patient prognosis (50,51).

The keyword burst detection analysis showed that "papillary" had the highest burst intensity. In recent years, "active surveillance" has become a burst word, and the re-emergence of burst words such as "microcarcinoma" and "differentiated thyroid cancer" indicates that the classification of thyroid cancer has again become an important area of research. PTC is the most common type of DTC, and the increase in the incidence of thyroid cancer over the past two decades primarily involved early-stage PTC (52,53). As a result of extensive screening using highly sensitive imaging equipment, an increasing number of clinically asymptomatic papillary thyroid microcarcinomas (PTMCs) are being detected, which have a low degree of malignancy and require less aggressive treatment (54,55). There is growing concern about the overdiagnosis and overtreatment of thyroid cancer, which is reflected in changes in surgical strategies and postoperative management, the controversy as to the extent of surgery, and the implementation of stricter restrictions for postoperative RAI therapy (9,11,56). Patients diagnosed with low-risk PTMC in recent years have had the following two management options: (I) surgical treatment; and (II) active surveillance (AS). Almost no other cancer has a similar management approach as that used for thyroid cancer. Currently, some consensus has been reached in relation to AS, with studies (57,58) suggesting that immediate surgery and AS have comparable oncologic outcomes, and that AS is superior to surgical treatment in terms of quality of life because of the potential of postoperative complications. However, the evidence in favor of AS is not sufficiently strong at this stage. First, there is a lack of reliable molecular markers to predict the aggressive behavior of PTMC. The 600th amino acid in V-Raf Murine Sarcoma Viral Oncogene Homolog B (BRAF) is mutated from valine to glutamic acid (this mutation is abbreviated as V600E). BRAF V600E and telomerase reverse transcriptase (TERT) promoter mutations are considered risk factors for PTC progression (59,60). However, some studies (61,62) have shown that BRAF and TERT promoter mutations are not associated with the adverse clinical features of PTMC. Second, there are geographical differences between economic incomes. Middle-income and low-income countries may not have the necessary conditions to implement AS, which requires multidisciplinary teams of surgeons and endocrinologists, high-resolution imaging equipment, and the organized and systematic follow-up of patients (63). Third, in relation to patient anxiety, AS appears to be superior to surgical treatment in terms of quality of life, but patients who choose AS are more likely to be anxious about the progression of the disease (60,64). In the future, more research needs to be conducted to compare AS and surgical treatments over the long term. Finally, the pathologic classification of thyroid cancer remains at the academic forefront of this field. Future research hotspots will probably derive from the study of the histopathologic features of thyroid cancer, especially microcarcinoma in differentiated thyroid cancer, and its prognosis.

Limitations

This study had some limitations. First, we only searched the SCI-E database in the WOSCC. Second, all information was extracted using scientometric tools, and thus the results may be biased. Finally, the uneven quality of the data collected from the literature in the study may have reduced the credibility of the map analysis.

Conclusions

Over the past 20 years, the number of publications in this field has generally continued to increase. Among the many research directions, follow-up, recurrent laryngeal nerve, and MTC are research hotspots in the postoperative management of thyroid cancer. Future research is likely to revolve around guidelines and consensus statements on the management of thyroid cancer, AS, and microcarcinoma in differentiated thyroid cancer.

Acknowledgments

The authors would like to thank Xiyuan Hospital, China Academy of Chinese Medical Sciences for supporting this work.

Funding: The work was supported by funding from the CACMS Innovation Fund (No. CI2021A01608).

Footnote

Peer Review File: Available at https://gs.amegroups.com/article/view/10.21037/gs-23-218/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://gs.amegroups.com/article/view/10.21037/gs-23-218/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Huang J, Ngai CH, Deng Y, et al. Incidence and mortality of thyroid cancer in 50 countries: a joinpoint regression analysis of global trends. Endocrine 2023;80:355-65.
2. Pizzato M, Li M, Vignat J, et al. The epidemiological landscape of thyroid cancer worldwide: GLOBOCAN estimates for incidence and mortality rates in 2020. Lancet Diabetes Endocrinol 2022;10:264-72.
3. Nabhan F, Dedhia PH, Ringel MD. Thyroid cancer, recent advances in diagnosis and therapy. Int J Cancer 2021;149:984-92.
4. Hayward NJ, Grodski S, Yeung M, et al. Recurrent laryngeal nerve injury in thyroid surgery: a review. ANZ J Surg 2013;83:15-21.
5. Dhillon VK, Rettig E, Noureldine SI, et al. The incidence of vocal fold motion impairment after primary thyroid and parathyroid surgery for a single high-volume academic surgeon determined by pre- and immediate post-operative fiberoptic laryngoscopy. Int J Surg 2018;56:73-8.
6. Mohammad R, Huh G, Cha W, et al. Recurrent Laryngeal Nerve Paralysis Following Thyroidectomy: Analysis of Factors Affecting Nerve Recovery. Laryngoscope 2022;132:1692-6.
7. Benmiloud F, Godiris-Petit G, Gras R, et al. Association of Autofluorescence-Based Detection of the Parathyroid Glands During Total Thyroidectomy With Postoperative Hypocalcemia Risk: Results of the PARAFLUO Multicenter Randomized Clinical Trial. JAMA Surg 2020;155:106-12.
8. Lynch J, Parameswaran R. Management of unilateral recurrent laryngeal nerve injury after thyroid surgery: A review. Head Neck 2017;39:1470-8.
9. Tuttle RM. Controversial Issues in Thyroid Cancer Management. J Nucl Med 2018;59:1187-94.
10. Durante C, Costante G, Filetti S. Differentiated thyroid carcinoma: defining new paradigms for postoperative management. Endocr Relat Cancer 2013;20:R141-54.
11. Wang TS, Sosa JA. Thyroid surgery for differentiated thyroid cancer - recent advances and future directions. Nat Rev Endocrinol 2018;14:670-83.
12. Doubleday A, Sippel RS. Surgical options for thyroid cancer and post-surgical management. Expert Rev Endocrinol Metab 2018;13:137-48.
13. Su J, Gao G, Xu H. Bibliometric analysis of research on thyroid ultrasonography. Gland Surg 2021;10:3283-93.
14. Thompson DF, Walker CK. A descriptive and historical review of bibliometrics with applications to medical sciences. Pharmacotherapy 2015;35:551-9.
15. Huang F, Wang L, Jia H. Research trends for papillary thyroid carcinoma from 2010 to 2019: A systematic review and bibliometrics analysis. Medicine (Baltimore) 2021;100:e26100.
16. Chen C, Song M. Visualizing a field of research: A methodology of systematic scientometric reviews. PLoS One 2019;14:e0223994.
17. Wang H, Yu Y, Wang K, et al. Bibliometric Insights in Advances of Anaplastic Thyroid Cancer: Research Landscapes, Turning Points, and Global Trends. Front Oncol 2021;11:769807.
18. Sabe M, Pillinger T, Kaiser S, et al. Half a century of research on antipsychotics and schizophrenia: A scientometric study of hotspots, nodes, bursts, and trends. Neurosci Biobehav Rev 2022;136:104608.
19. Synnestvedt MB, Chen C, Holmes JH. CiteSpace II: visualization and knowledge discovery in bibliographic databases. AMIA Annu Symp Proc 2005;2005:724-8.
20. Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines

Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid 2016;26:1-133.
21. American Thyroid Association (ATA) Guidelines Taskforce on Thyroid Nodules and Differentiated Thyroid Cancer, Cooper DS, Doherty GM, et al. Revised American Thyroid Association management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid 2009;19:1167-214.
22. Cooper DS, Doherty GM, Haugen BR, et al. Management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid 2006;16:109-42.
23. Perros P, Boelaert K, Colley S, et al. Guidelines for the management of thyroid cancer. Clin Endocrinol (Oxf) 2014;81 Suppl 1:1-122.
24. Lim H, Devesa SS, Sosa JA, et al. Trends in Thyroid Cancer Incidence and Mortality in the United States, 1974-2013. JAMA 2017;317:1338-48.
25. Pacini F, Schlumberger M, Dralle H, et al. European consensus for the management of patients with differentiated thyroid carcinoma of the follicular epithelium. Eur J Endocrinol 2006;154:787-803.
26. Wells SA Jr, Asa SL, Dralle H, et al. Revised American Thyroid Association guidelines for the management of medullary thyroid carcinoma. Thyroid 2015;25:567-610.
27. Francis GL, Waguespack SG, Bauer AJ, et al. Management Guidelines for Children with Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid 2015;25:716-59.
28. Randolph GW, Duh QY, Heller KS, et al. The prognostic significance of nodal metastases from papillary thyroid carcinoma can be stratified based on the size and number of metastatic lymph nodes, as well as the presence of extranodal extension. Thyroid 2012;22:1144-52.
29. Adam MA, Thomas S, Youngwirth L, et al. Is There a Minimum Number of Thyroidectomies a Surgeon Should Perform to Optimize Patient Outcomes? Ann Surg 2017;265:402-7.
30. Wang LY, Ganly I. Post-treatment surveillance of thyroid cancer. Eur J Surg Oncol 2018;44:357-66.
31. Liu N, Tang L, Chen Y, et al. A Combination of Contrast-Enhanced Ultrasound and Thyroglobulin Level in Fine-Needle Aspirates Improves Diagnostic Accuracy for Metastatic Lymph Nodes of Papillary Thyroid Carcinoma. J Ultrasound Med 2022;41:2431-43.
32. Döner RK, Sager S, Görtan FA, et al. What is the role of florine-18 fluorodeoxyglucose/positron emission tomography/computed tomography imaging in well-differentiated thyroid cancers with negative iodine-131 scan high thyroglobulin and normal anti-thyroglobulin levels. J Cancer Res Ther 2016;12:1010-7.
33. Jayasekara J, Jonker P, Lin JF, et al. Early postoperative stimulated serum thyroglobulin quantifies risk of recurrence in papillary thyroid cancer. Surgery 2020;167:40-5.
34. Thai JN, De Marchena IR, Nehru VM, et al. Low correlation between serum thyroglobulin and (131) I radioiodine whole body scintigraphy: implication for postoperative disease surveillance in differentiated thyroid cancer. Clin Imaging 2022;87:1-4.
35. Prpić M, Franceschi M, Romić M, et al. Thyroglobulin as a tumor marker in differentiated thyroid cancer - clinical considerations. Acta Clin Croat 2018;57:518-27.
36. Knappe L, Giovanella L. Life after thyroid cancer: the role of thyroglobulin and thyroglobulin antibodies for postoperative follow-up. Expert Rev Endocrinol Metab 2021;16:273-9.
37. Ling Y, Zhao J, Zhao Y, et al. Role of intraoperative neuromonitoring of recurrent laryngeal nerve in thyroid and parathyroid surgery. J Int Med Res 2020;48:300060520952646.
38. Păduraru DN, Ion D, Carsote M, et al. Post-thyroidectomy Hypocalcemia - Risk Factors and Management. Chirurgia (Bucur) 2019;114:564-70.
39. Joliat GR, Guarnero V, Demartines N, et al. Recurrent laryngeal nerve injury after thyroid and parathyroid surgery: Incidence and postoperative evolution assessment. Medicine (Baltimore) 2017;96:e6674.
40. Lorenz K, Raffaeli M, Barczyński M, et al. Volume, outcomes, and quality standards in thyroid surgery: an evidence-based analysis-European Society of Endocrine Surgeons (ESES) positional statement. Langenbecks Arch Surg 2020;405:401-25.
41. Hsieh CY, Tan H, Huang HF, et al. Optimization of Intraoperative Neural Monitoring of the Recurrent Laryngeal Nerve in Thyroid Surgery. Medicina (Kaunas) 2022;58:495.
42. Wong KP, Mak KL, Wong CK, et al. Systematic review and meta-analysis on intra-operative neuro-monitoring in high-risk thyroidectomy. Int J Surg 2017;38:21-30.
43. Davey MG, Cleere EF, Lowery AJ, et al. Intraoperative recurrent laryngeal nerve monitoring versus visualisation alone - A systematic review and meta-analysis of randomized controlled trials. Am J Surg 2022;224:836-41.
44. Cirocchi R, Arezzo A, D'Andrea V, et al. Intraoperative neuromonitoring versus visual nerve identification for prevention of recurrent laryngeal nerve injury in adults undergoing thyroid surgery. Cochrane Database Syst Rev

2019;1:CD012483.
45. Cleere EF, Davey MG, Young O, et al. Intra-operative nerve monitoring and recurrent laryngeal nerve injury during thyroid surgery: a network meta-analysis of prospective studies. Langenbecks Arch Surg 2022;407:3209-19.
46. Leimbach RD, Hoang TD, Shakir MKM. Diagnostic Challenges of Medullary Thyroid Carcinoma. Oncology 2021;99:422-32.
47. Passos I, Stefanidou E, Meditskou-Eythymiadou S, et al. A Review of the Significance in Measuring Preoperative and Postoperative Carcinoembryonic Antigen (CEA) Values in Patients with Medullary Thyroid Carcinoma (MTC). Medicina (Kaunas) 2021;57:609.
48. Kim M, Kim BH. Current Guidelines for Management of Medullary Thyroid Carcinoma. Endocrinol Metab (Seoul) 2021;36:514-24.
49. Haddad RI, Bischoff L, Ball D, et al. Thyroid Carcinoma, Version 2.2022, NCCN Clinical Practice Guidelines in Oncology. J Natl Compr Canc Netw 2022;20:925-51.
50. Ceolin L, Duval MADS, Benini AF, et al. Medullary thyroid carcinoma beyond surgery: advances, challenges, and perspectives. Endocr Relat Cancer 2019;26:R499-518.
51. Gild ML, Tsang VHM, Clifton-Bligh RJ, et al. Multikinase inhibitors in thyroid cancer: timing of targeted therapy. Nat Rev Endocrinol 2021;17:225-34.
52. Cabanillas ME, McFadden DG, Durante C. Thyroid cancer. Lancet 2016;388:2783-95.
53. Miranda-Filho A, Lortet-Tieulent J, Bray F, et al. Thyroid cancer incidence trends by histology in 25 countries: a population-based study. Lancet Diabetes Endocrinol 2021;9:225-34.
54. Filetti S, Durante C, Hartl D, et al. Thyroid cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up†. Ann Oncol 2019;30:1856-83.
55. Krajewska J, Kukulska A, Oczko-Wojciechowska M, et al. Early Diagnosis of Low-Risk Papillary Thyroid Cancer Results Rather in Overtreatment Than a Better Survival. Front Endocrinol (Lausanne) 2020;11:571421.
56. Pasqual E, Sosa JA, Chen Y, et al. Trends in the Management of Localized Papillary Thyroid Carcinoma in the United States (2000-2018). Thyroid 2022;32:397-410.
57. Oda H, Miyauchi A, Ito Y, et al. Incidences of Unfavorable Events in the Management of Low-Risk Papillary Microcarcinoma of the Thyroid by Active Surveillance Versus Immediate Surgery. Thyroid 2016;26:150-5.
58. Saravana-Bawan B, Bajwa A, Paterson J, et al. Active surveillance of low-risk papillary thyroid cancer: A meta-analysis. Surgery 2020;167:46-55.
59. Xing M, Liu R, Liu X, et al. BRAF V600E and TERT promoter mutations cooperatively identify the most aggressive papillary thyroid cancer with highest recurrence. J Clin Oncol 2014;32:2718-26.
60. Sugitani I, Ito Y, Takeuchi D, et al. Indications and Strategy for Active Surveillance of Adult Low-Risk Papillary Thyroid Microcarcinoma: Consensus Statements from the Japan Association of Endocrine Surgery Task Force on Management for Papillary Thyroid Microcarcinoma. Thyroid 2021;31:183-92.
61. de Biase D, Gandolfi G, Ragazzi M, et al. TERT Promoter Mutations in Papillary Thyroid Microcarcinomas. Thyroid 2015;25:1013-9.
62. Lee J, Ha EJ, Roh J, et al. Presence of TERT ± BRAF V600E mutation is not a risk factor for the clinical management of patients with papillary thyroid microcarcinoma. Surgery 2021;170:743-7.
63. Cernea CR, Matos LL, Eugênio C, et al. Active Surveillance of Thyroid Microcarcinomas: a Critical View. Curr Oncol Rep 2022;24:69-76.
64. Yoshida Y, Horiuchi K, Okamoto T. Patients' View on the Management of Papillary Thyroid Microcarcinoma: Active Surveillance or Surgery. Thyroid 2020;30:681-7.

Cite this article as: Yang X, Wang Y, Luo Y, Guo T, Zhang G. A dynamic study of the postoperative management of thyroid cancer from 2003 to 2022: a bibliometric analysis. Gland Surg 2023;12(11):1579-1593. doi: 10.21037/gs-23-218