Journal of Multidisciplinary Healthcare Dovepress

Open Access Full Text Article REVIEW

Research-Oriented Hospitals in China: A Bibliometric and Visualization Analysis Based CiteSpace

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Abstract: Research-oriented hospitals represent the primary direction for the future development of large-scale, high-level hospitals in China. Research-oriented hospitals, increasingly highlighted in domestic policies, lacks a comprehensive analysis of existing research outcomes. Bibliometric evaluates scientific research endeavors and trends in disciplines by statistically analyzing literature data. Citespace is a widely used bibliometric software that helps researchers visualize research hotspots and trends in a specific field by measuring and modeling literature data from that area. This study employs CiteSpace software to conduct a bibliometric analysis and visualization analysis of the literature in the field of research-oriented hospitals, spanning publications from 2003 to 2023 and sourced from databases including the China National Knowledge Infrastructure (CNKI), Wanfang, and Weipu (VIP). Findings indicate rapid publication growth from 2010 to 2016, followed by fluctuations characterized by alternating declines and increases. In terms of the distribution of authors and institutions, the study observes a relatively modest level of collaboration among highly productive researchers and research institutions, suggesting room for enhanced interdisciplinary and institutional partnerships. Moreover, research hotspots in the field of research-oriented hospitals can be categorized into hospital development strategy, hospital management, and technological innovation. Considering the limitations of current research and the evolution of social needs, this study suggests that future research should focus more on clarifying the essence of research-oriented hospitals, developing targeted development strategies, and addressing the numerous obstacles faced during the hospital innovation process. In conclusion, this bibliometric analysis provides a snapshot of the current research status and trend. The insights gained from this research not only aim to inform future studies but also to inspire relevant stakeholders such as policy makers, hospital managers, and scholars to strengthen practical actions, enhance the construction and operation of research-oriented hospitals, thereby improving healthcare outcomes for populations.

Keywords: research-oriented hospital, bibliometric analysis, CiteSpace

Introduction

The term "research-oriented hospital" is unique in China and represents an innovative modern hospital management model and a health collaboration strategy. Initially introduced in 2003 by Jiang Changbin from Ruijin Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, in the article "Establishment of Research-Oriented Hospitals through Science and Education", the definition of a research-oriented hospital was not thoroughly elaborated upon in the publication.[1] Since then, domestic scholars have conducted significant explorations regarding the definition, theory, and practice of research-oriented hospitals. Subsequently, in 2004, the Chinese People's Liberation Army (PLA) General Hospital took the lead in establishing a research-oriented hospital. In October 2005, Qin Yinhe, then head of the Chinese PLA General Hospital, published the article "Exploration and Practice in Building Research-Oriented Hospitals", which articulated the definition of a research-oriented hospital as a large-scale comprehensive hospital with the fundamental task of completing clinical medical work of high quality, the prominent advantage of training outstanding and top-notch talents, the important mission of innovative scientific research, and the level mark of formulating or revising clinical

Received: 11 September 2024
Accepted: 1 November 2024
Published: 15 November 2024

medical standards and norms.[2] In September 2021, the Chinese Research Hospital Association (CRHA) successively issued several key documents, including the "Guidelines for the Construction of Research-Oriented Hospitals in China", "Evaluation Indicator System for Research-Oriented Hospitals", "Evaluation Indicator System for Research-Oriented Disciplines", and "Evaluation Indicator System for Research-Oriented Talents (Physicians)". These documents provided normative guidance for the construction of research-oriented hospitals in China, thereby institutionalizing the construction of research-oriented hospitals in China. Drawing on international best practices and in response to the demands of the times and technological advancements, China's research-oriented hospitals are defined as high-level medical institutions that integrate medical care, education, and research. These hospitals not only provide high-quality clinical services but also prioritize research and education as core functions. They are dedicated to the development of cutting-edge medical technologies and the translation of research into clinical applications. As a result, they represent a sustainable, integrated model and an effective practice of hospital management innovation.[3] Importantly, Chinese research-oriented hospitals have reached a new stage where they need to be reviewed and summarized, both practically and academically.

Internationally, concepts similar to China's research-oriented hospitals or more typical examples include the United States' Johns Hopkins Hospital, which is representative of Academic Medical Centers (AMCs),[4] the Teaching Hospitals (THs) in the UK such as St. Mary's Hospital and Nottingham University Hospitals,[5,6] and the Academic Health Science Centers (AHSCs) established starting in 2009 based on the NHS and England's universal health system.[7] However, AHSCs originated in North America and have played an indispensable role in mediating tensions among stakeholders within the healthcare system and primary care, as well as in community-based medical training.[7,8] Research hospitals in Canada are characterized by a close relationship with local universities, with many university faculty members working in the hospitals, while hospital medical staff also teach at the universities. Since 2011, the Canada's research intelligence agency, Research Infosource Inc., has annually ranked 40 research hospitals based on research expenditure and research intensity. According to the latest results for 2023, the top three—University Health Network (UHN), Hospital for Sick Children, and McGill University Health Centre (MUHC)—all showed varying degrees of increase in research expenditures in 2022 compared to the previous year.[9] In East Asia, South Korea's teaching hospitals can be categorized into two groups based on their developmental sequence: university-based hospitals and hospital-based hospitals.[10] Japan's research hospitals also include "specific function hospitals" (特定機能病院), which, while providing high-level medical services, are also committed to the development of medical human resources and clinical research work, with most being affiliated hospitals under the national research and university medical college systems.[11] Singapore's research hospitals often appear in the public as "academic medical groups" (AMGs), emphasizing multidisciplinary and interdisciplinary cooperation, along with the integration of clinical research and education. Notable examples include the National University Health System (NUHS) and SingHealth.[12] In summary, research-oriented hospitals in different countries each have their own characteristics and unique management systems, but the main theme of "focusing on clinical medicine while paying attention to medical research and medical education" is generally similar, and these research hospitals have made significant contributions to the global health and human-being healthcare. Table 1 summarized the key differences between Chinese research-oriented hospitals, traditional hospitals, and various types of international research-oriented hospitals.

A wealth of evidence indicates that top-tier research-oriented hospitals with both clinical and research excellence worldwide have advanced their clinical treatment capabilities through research and maintained a continuous, positive interaction between clinical practice and scientific research, positioning them at the forefront of global healthcare.[3] For instance, the 2021 Global Nature Index ranking revealed that of the among the top 50 healthcare institutions, the first 19 were all US -based medical institutions. Furthermore, US healthcare institutions dominated the list with 32 entries, all of which are academic research hospitals. The scientific research output of these hospitals directly correlates with their clinical care standards, the educational quality of their affiliated medical schools, and the overall healthcare level of their surrounding cities. Recognizing the advantages of developing research-oriented hospitals, China has closely followed international trends and invested in the construction and development of its own research-oriented hospitals, with improvements focusing on medical quality, technological innovation, talent development, standards and regulations, experimental platforms, digitalization, and medical ethics. By 2024, China has made significant strides in the Global Nature Index for healthcare institutions. Although US medical institutions still led with 42 entries (the majority being research hospitals), China closely followed with 25 entries, 23 of which were research-oriented hospitals.[13] Notably,

Table 1 Key Differences Between Various Types of Hospitals

Type	Primary Focus	Research Innovation	International Collaboration	Government Regulation
Chinese Traditional Hospitals	Providing clinical services to the public, with limited research and education functions.	Limited innovation, mostly focused on applied research in clinical settings.	Minimal international collaboration, mainly serving domestic healthcare needs.	Government-led, with strong regulation on healthcare quality, pricing, and resource allocation.
Chinese Research-Oriented Hospitals	Focus on research, clinical care, and education, with an emphasis on translational medicine.	Strong in basic research and clinical translation, promoting rapid innovation.	Gradually expanding internationally, though still lagging in some areas.	Government-led, with significant policy support.
Academic Medical Centers	Highly integrated research, education, and clinical care, with a focus on innovation and breakthroughs.	Leading in research innovation globally, with strong capabilities.	High level of international collaboration, involved in global research projects.	University-led, with diverse funding sources.
Teaching Hospitals	Primarily responsible for clinical care and medical education, with less focus on research.	Engages in clinical and applied research, often focused on improving patient care and medical education.	Focused more on national healthcare needs.	Managed through collaboration between medical schools and hospitals; In UK, supported by the government and NHS Foundation Trust.
Academic Health Science Centers	Comprehensive health and public health research, emphasizing the intersection of policy and medicine.	Integrates health sciences and drives innovation in public health and policy.	High degree of international collaboration, especially in public health.	Managed through multi-institutional collaboration, with complex governance.
Canadian Research Hospitals	Focus on research, clinical care, and medical education, with specializations in specific areas like pediatrics, oncology, and health systems.	Emphasize translational medicine, with strong programs in oncology, cardiovascular science, and pediatrics.	High degree of international collaboration, especially in population health, pediatrics, and health systems research.	Government-regulated, with funding from provincial and federal governments, alongside philanthropic contributions; Simultaneous partnerships with the public and private sectors.
Japanese Specific Function Hospitals	Specialized medical services, with a focus on treating complex and rare diseases.	Innovation primarily in clinical applications, with less emphasis on basic research.	Low degree of international collaboration, primarily serving domestic needs.	Strictly regulated and accredited by the Japanese government.
Singaporean Academic Medical Groups	Integrated clinical care, education, and research, with an emphasis on translational medicine.	Strong in translational medicine and clinical applications, focusing on innovation.	High degree of international collaboration, particularly influential in Southeast Asia.	Supported by the government, commercial and social capital, with a collaborative model between universities and healthcare systems.

research-oriented hospitals have achieved remarkable success in reducing mortality rates and improving interventions for specific diseases. For example, the Mayo Clinic in the US has made significant contributions to reducing cardiovascular disease mortality and successfully implemented projects aimed at lowering hospital mortality rates.[14,15] And research-oriented hospitals under SingHealth in Singapore played a pivotal role in addressing the public health crisis during the COVID-19 pandemic and in ensuring the safety of healthcare workers.[16,17] This is why, over the past decade, the Chinese government, health authorities, and public hospitals have aligned with global trends, actively engaging in the transformation of traditional hospitals and the enhancement of research-oriented hospitals.

When the focus shifts to the practice of research-oriented hospitals in China, it becomes evident that the development of these institutions has had a profound impact on the country's healthcare policies, innovation capacity, and economic growth. Firstly, in terms of China's healthcare policy, over the past two decades, with the continuous introduction of relevant policies and the gradual revelation and public recognition of the value that research-oriented hospitals have

created for social public health, the attention given to research-oriented hospitals by the government and academia has also been increasing, as has the research in this area. As early as 2010, the "Twelfth Five-Year Plan for the Development of Medical Science and Technology" proposed to accelerate the development of medical technology and improve the overall health level of the population. Since the issuance of the "Outline of the Healthy China 2030 Plan" in 2016, which clearly directed the provision of high-quality and efficient medical services and the strengthening of the construction of healthcare human resources, China has successively promulgated in 2021 the "Administrative Measures for Clinical Research Initiated by Researchers in Medical and Health Institutions (Trial)", "Administrative Measures for National Medical Centers (Trial)", and other documents that have provided policy guidance for the standardized guidance and industry management of research-oriented hospitals. Moreover, the requirement of "accelerating the construction of research-oriented hospitals" has been included in the National Development and Reform Commission's "14th Five-Year Plan for Bioeconomic Development" and in the work programs of the Ministry of Science and Technology and other twelve ministries from the year 2022.[18] Consequently, some prefecture-level cities have also responded to the national call and arrangements, and have successively implemented policy innovation work on their own initiative. For example, Beijing promulgated the "14th Five-Year Plan for the Construction of a Healthy Beijing" and "Several Measures to Accelerate the High-Quality and Efficient Development of Research-Oriented Wards in Beijing" in 2021 and 2022, which greatly promoted the construction and development of local research-oriented hospitals. As of May 2024, the People's Government of Beijing Municipality publicly released the "Beijing Action Plan for Accelerating Collaborative Innovation in Medicine and Healthcare (2024–2026)", which further emphasizes key initiatives aimed at "promoting the high-level development of research-oriented hospitals".[19] Secondly, in terms of innovation capacity, many hospitals in China have actively fostered their own innovation capabilities or developed new institutional frameworks to meet the demands of building and developing research-oriented hospitals. For instance, the Chinese PLA General Hospital has promoted management innovation to establish a research-driven operational mechanism for scientific research within the hospital.[20] Similarly, Shanghai Jiao Tong University School of Medicine has highlighted the importance of establishing a dedicated clinical research team as an innovative initiative from the perspective of talent development in research-oriented hospitals.[21] Moreover, as seen from information released of the CRHA, the development of research-oriented hospitals has already driven innovation in various areas, including pharmaceuticals, medical devices, smart healthcare projects, research topics, and social collaboration.[22] Finally, as an integrated model, the establishment and development of research-oriented hospitals have become a key driver of China's socio-economic development by promoting medical technology innovation, stimulating the growth of related industries, optimizing the allocation of healthcare resources, creating employment opportunities, and enhancing international influence.[23]

On the academic side, some scholars have taken specific medical institutions as research objects and summarized the experiences in discipline construction, talent management, scientific research management, and informatization construction that have been achieved in the construction process of research-oriented hospitals.[24–27] He Zhenxi, the head of the CRHA, along with relevant experts, proposed a guideline for the development of research-oriented hospitals based on ten key modules: strategic positioning, organizational management, clinical diagnosis and treatment, innovation and translation, discipline construction, talent cultivation, platform support, incentive mechanisms, and cultural development.[18] There are also some scholars who have elaborated on the definition and connotation of research-oriented hospitals, the path of construction, and the management system, providing a theoretical basis for establishing an overall development strategy for research-oriented hospitals.[3,28,29] In terms of bibliometric analysis of related literature, some scholars used the CiteSpace software to conduct visual analysis in 2016 and 2018, respectively,[30,31] but the literature included in these two articles was only up to 2015. To compare the four types of hospitals that have emerged in China in recent years (research-oriented, innovative, learning-oriented, and academic-oriented), Song and Meng also conducted a bibliometric analysis of 339 documents on research-oriented hospitals, but the literature they included only extended to the end of December 2016.[32]

The continuous advancement of the construction of research-oriented hospitals, especially after China officially proposed the goal of building a "Healthy China" in 2016, signifies the arrival of the era of "Great Health" in China. Governments at all levels have gradually realized the importance of the "health priority" principle in specific actions of public governance and public services.[33] Therefore, the development strategies, talent training, academic research, and

practical innovation related to research-oriented hospitals will inevitably step up to a "new level" with the advancement of the "Healthy China" strategy. Given that research-oriented hospitals in China have gradually become more systematized, along with the increasing emphasis on their importance and significance in national and local policies, particularly following the official launch of the "Healthy China" strategy in 2016, there has been a noticeable lack of updated bibliometric studies on this topic. Therefore, it is both necessary and urgent to conduct a bibliometric analysis that aligns with current developments, comprehensively reviewing and summarizing research hotspots and trends related to Chinese research-oriented hospitals. The visual representation of these findings would also be crucial to understanding the evolving landscape of this field.

In summary, this study used the CiteSpace visualization analysis software for bibliometric analysis of the published literature related to research-oriented hospitals up to 2023, to systematically understand the current state of research and research hotspots, and to systematically analyze and summarize existing research to provide feasible guidance and evidence-based support for future theory and practice. At the same time, this study also hopes to answer the following three questions through bibliometric and hotspot visualization analysis: a) From 2003 to 2023, what patterns and trends are exhibited in the publication time, authors, and institutions of research on research-oriented hospitals? b) From 2003 to 2023, what are the core hotspots and popular directions of research on research-oriented hospitals in China? And c) Based on the analysis of the included research over the past 20 years, what are the future development trends and potential hot research topics of research-oriented hospitals?

Materials and Methods

Data Sources and Screening Strategy

The China National Knowledge Infrastructure (CNKI) (https://www.cnki.net/), Weipu (VIP) (http://www.cqvip.com/), and WanFang (https://www.wanfangdata.com.cn/) were used as literature sources. The reasons for this choice are as follows. In the preliminary search, we found that: a) The concept of research-oriented hospitals was proposed by Chinese researchers, and the main researchers currently are Chinese scholars. b) A large number of publications are written in Chinese and published in journals in China. c) Only a few articles written in English can be retrieved from the Web of Science, and the authors of these articles are still Chinese scholars. Therefore, this study utilized mainstream Chinese databases for retrieval, almost achieving full coverage of relevant literature on the topic to ensure the accuracy of the research results.

The search strategy was "[subject = (research hospital) OR (research-oriented hospital)] OR [title, keyword, and abstract = (research hospital) OR (research-oriented hospital)]". All the data were acquired on January 5, 2024. The publication years of the selected literature ranged from 2003 to 2023. A total of 4124 articles were initially retrieved. These articles were exported in Refworks format and then imported into NoteExpress software for further screening.

The inclusion criteria were as follows: a) Literature retrieved from the CNKI, VIP, and WanFang databases via the aforementioned search strategy. b) Literature related to the field of research-oriented hospitals. The exclusion criteria were as follows: a) Duplicates or publications for which the full text was not available. b) Reviews, press releases, commentaries, conference briefs, case reports, and science fiction. c) Literature less relevant to the focal topic. The data extraction process was conducted by two authors, who screened 4124 articles based on the inclusion and exclusion criteria, and eliminated 1035 duplicate publications, 32 articles with incomplete bibliographic information, editorials, news articles, and so on. After reading the abstracts and full texts, 2536 articles not related to the topic were removed, resulting in a final selection of 494 articles for visual analysis. The detailed procedure of literature selection is shown in Figure 1.

Bibliometric and Visualization Analysis

Bibliometric analysis is a quantitative method that involves the analysis of large quantities of bibliometric data, aiding in the identification of influential authors, collaboration patterns, research hotspots, and emerging areas within a particular field or research topic.[34] CiteSpace software, developed by Professor Chaomei Chen, is a Java application for analyzing and visualizing a scientific knowledge map at first.[35] It is a widely used bibliometric analysis tool that assists in visualizing and analyzing research networks, clusters, and trends. In terms of research areas, CiteSpace software has

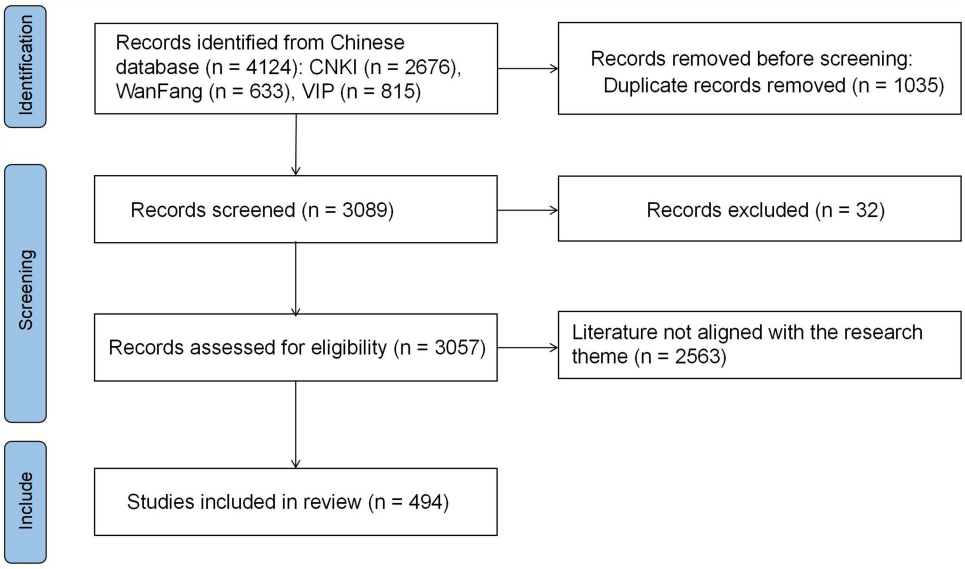

Figure 1 The flow chart of literature selection.

been extensively applied in fields such as library and information science, management science, and technology science. In terms of functionality, it primarily focuses on research frontier and research hotspot analysis, co-occurrence network analysis of keywords, authors, institutions, and citations, and so on, providing a comprehensive overview of the research landscape and facilitating the identification of key research themes and their evolution over time.[36–38]

In this study, the selected literature data were imported into CiteSpace 6.1.R6, which utilizes algorithms to perform visualization of authors, institutions, and keywords in the field of research-oriented hospitals. The process of data processing involves downloading data, converting formats, establishing project, and performing visualization analysis. A total of 494 documents were exported from NoteExpress software in RefWorks format and imported into CiteSpace software, using its data format converter for data transformation. The converted literature data can be used for further visualization analysis. The parameters for CiteSpace 6.2.R6 were set as follows: 1) Time spans from 2003 to 2023; 2) Each slice year set to 1; 3) Node type were author/institution/keyword; 4) the Minimum Spanning Tree (MST) algorithm selected to simplify the network. All other parameters were the default settings. The co-occurrence analysis of authors and institutions was selected to determine highly productive and influential researchers and research institutions in the field of research-oriented hospitals. Additionally, it sheds light on the collaboration patterns among different researchers and institutions. Co-occurrence analysis and clustering analysis were applied to keywords. Co-occurrence analysis of keywords uncovers popular research topics in the field. CiteSpace software extracts keywords from the literature and merges similar keywords to generate a network of keyword co-occurrence. Based on this network, keyword clustering analysis was performed to identify the research hotspots in the field.

Results

Literature Distribution Characteristics

The number of annual publications can reflect the hotspots and research trends in a specific research field to some extent. As shown in Figure 2, it depicts the evolution of the annual publication volume related to research-oriented hospitals in China from 2003 to 2023. Generally, the volume of these research outputs is relatively low. The publication numbers show an increasing trend followed by a decreasing trend, which can be divided into four stages. The first stage spans from 2003 to 2009, representing the initial exploration phase of research-oriented hospitals. During this period, the annual publication volume remained below ten articles and showed only a slight increase until 2010. The second stage, spanning from 2010 to 2016, is characterized by rapid growth in this sector, with the annual publication volume significantly rising and peaking at 87 publications in 2016. However, the third stage, from 2016 to 2018, saw a sharp

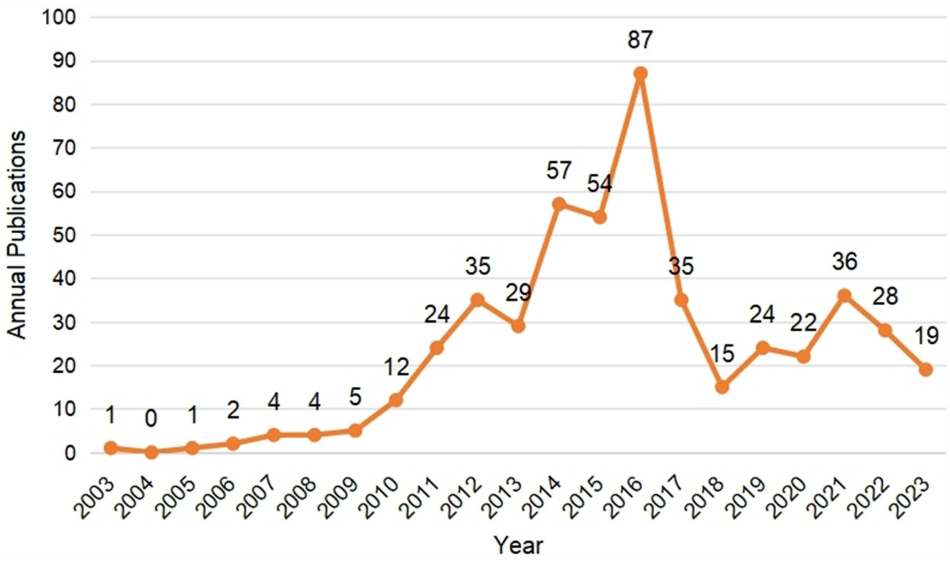

Figure 2 Annual trends of publications in the field of research-oriented hospitals from 2003 to 2023.

decline in research enthusiasm, resulting in a rapid decrease in publication numbers. Since 2019, the fourth stage has begun, marking a resurgence and continuous deepening of research on research-oriented hospitals. This shift may be attributed to the gradual implementations of a series of policies supporting the construction and development of research-oriented hospitals in several economically developed cities in China, including Beijing, Shanghai, Shenzhen. In 2016, the "Outline of the Healthy China 2030 Plan" advocated for a transition from a "disease-centered" to a "people's health-centered" principle. In 2019, the Chinese government further refined this grand blueprint by formulating a specific implementation plan for "Healthy China 2030", aiming to provide strategic direction to address the main challenges faced by China's healthcare system. To improve the health levels of Chinese, reduce the overall healthcare burden, and enhance accessibility to health services, medical institutions have been given a renewed mission, which is to be demand-oriented and actively engage in technological innovation and the transformation of achievements.[39] This means that to strengthen the guiding and supporting ability of health and medical technology innovation for the construction of "Healthy China", building high-level research-oriented hospitals has become particularly important. This has also prompted several cities to propose specific implementation measures. For example, Beijing plans to establish approximately 20 research-oriented wards by 2020. Shanghai regards clinical research centers and research-oriented hospitals as pivotal platforms for supporting clinical research and fostering the biopharmaceutical industry. Shenzhen encourages city-level Grade III hospitals to establish research-oriented beds specifically for high-level clinical medical research.[18] With ongoing exploration and practice regarding the construction of research-oriented hospitals across different regions, we anticipate a continued growth in academic interest in this area.

Author Distribution

The top-rank prolific authors are shown in Table 2. The most prolific author in the field of research-oriented hospitals was Yao Jun from the Chinese PLA General Hospital (n =16). Besides, as one of the vice head of the CRHA, he is committed to exploring and guiding the establishment and development of research-oriented hospitals in China from a theoretical perspective. His research focuses on several key areas, including medical model innovation, optimization of scientific research management, deepening of discipline construction, and diversification of talent cultivation.

The author's collaboration network reflects the contributions of researchers in their respective fields and their collaborative relationships. In this network, each node denotes an individual author, the size of the author'name represents the number of papers published by that author. And the edges connecting the nodes represent collaborative relationships between authors, the color of the connecting lines indicates the time of the author's first collaboration. The author collaboration network for research-oriented hospitals is shown in Figure 3, with a total of 412 nodes and 525 links,

Table 2 Top Rank Authors in the Field of Research-Oriented Hospital

Rank	Author	Affiliation	Number of Publications
1	Yao Jun	Chinese PLA General Hospital	16
2	Wang Faqiang	Chinese Research Hospital Association	13
3	Qin Yinhe	Chinese PLA General Hospital	10
4	Lian Bin	The Affiliated Suzhou Hospital Of Nanjing University Medical School	8
5	Guo Yucheng	Chinese PLA General Hospital	7
5	Wang Yanjun	Chinese Research Hospital Association	7
5	Wang Dong	Chinese PLA General Hospital	7
8	Li Meina	Naval Medical University (Second Military Medical University)	7
8	Li Jinbo	The Southwest Hospital Of Army Medical University	6
8	Diao Tianxi	Academy Of Military Medical Sciences	6
8	Li Shuzhang	Chinese PLA General Hospital	6
8	Li Yong	Army Medical University (Third Military Medical University)	6
8	Xu Ping	Naval Medical University (Second Military Medical University)	6

and a network density value of 0.006. Among the author nodes, those of Yao Jun, Wang Faqiang, Qin Yinhe, and Lian Bin stand out, indicating that they have published a relatively high number of papers. From the connections presented in the diagram, despite the presence of a considerable number of research scholars in the field, collaborative efforts among authors remain limited, the number of authors in each network ranges from 2 to over 10. Most researchers predominantly participate in small-scale collaborations, which are primarily confined to colleagues within the same institution. Most authors' first collaborations occurred between 2012 and 2017, which coincides with a period of rapid growth in the literature and advancements in the field of research-oriented hospitals. However, there is a notable absence of extensive cross-institutional and cross-regional collaborations. This limitation suggests that the full potential of collaborative research has yet to be fully realized. For research-oriented hospitals, the lack of such collaborations could hinder their ability to access a wider range of expertise, resources, and innovative ideas, which are crucial for fostering breakthroughs and advancements in medical research.

Institution Distribution

After conducting the statistical analysis of the research institutions using NoteExpress software, the information on the institutions was refined based on the following criteria in order to ensure accuracy: a) Amalgamating various departments within a single institution. b) Treating the university and its associated hospitals as separate institutions. c) Consolidating various titles of a single institution (eg, historical and current designations) into one entity. Table 3 highlighted the top-rank prolific institutions. Noteworthy research contributions are attributed to the Chinese PLA General Hospital and the Shuguang Hospital Affiliated to Shanghai University of Traditional Chinese Medicine (TCM), with more than 40 publications each. The CRHA and the Naval Medical University (Second Military Medical University) have more than 10 publications each, while the remaining institutions have less than 10 publications each.

As shown in Figure 4, the institution cooperation network of research-oriented hospitals provides a detailed insight into the current landscape of research cooperation. Each node signifies an institution, the size of the institution name represents the number of papers it has published. The edges interconnecting the nodes represent collaborative relationships among the institutions, the color of the connecting lines indicates the timing of the institution's first collaboration endeavor. The network comprises 320 nodes and 119 links, with a network density value of 0.002, indicating that the research institutions have not yet formed extensive or close cooperation relationships. The diagram roughly forms five distinct collaborative networks among institutions, which generally appear to be independent and exhibit characteristics of "localized concentration and overall dispersion". Geographically, the majority of these prominent research institutions are located in economically prosperous regions, such as Beijing, Shanghai, and Jiangsu Province. These regions are not only important hubs for medical resources in China, but also centers for the biomedical industry, with a high frequency of

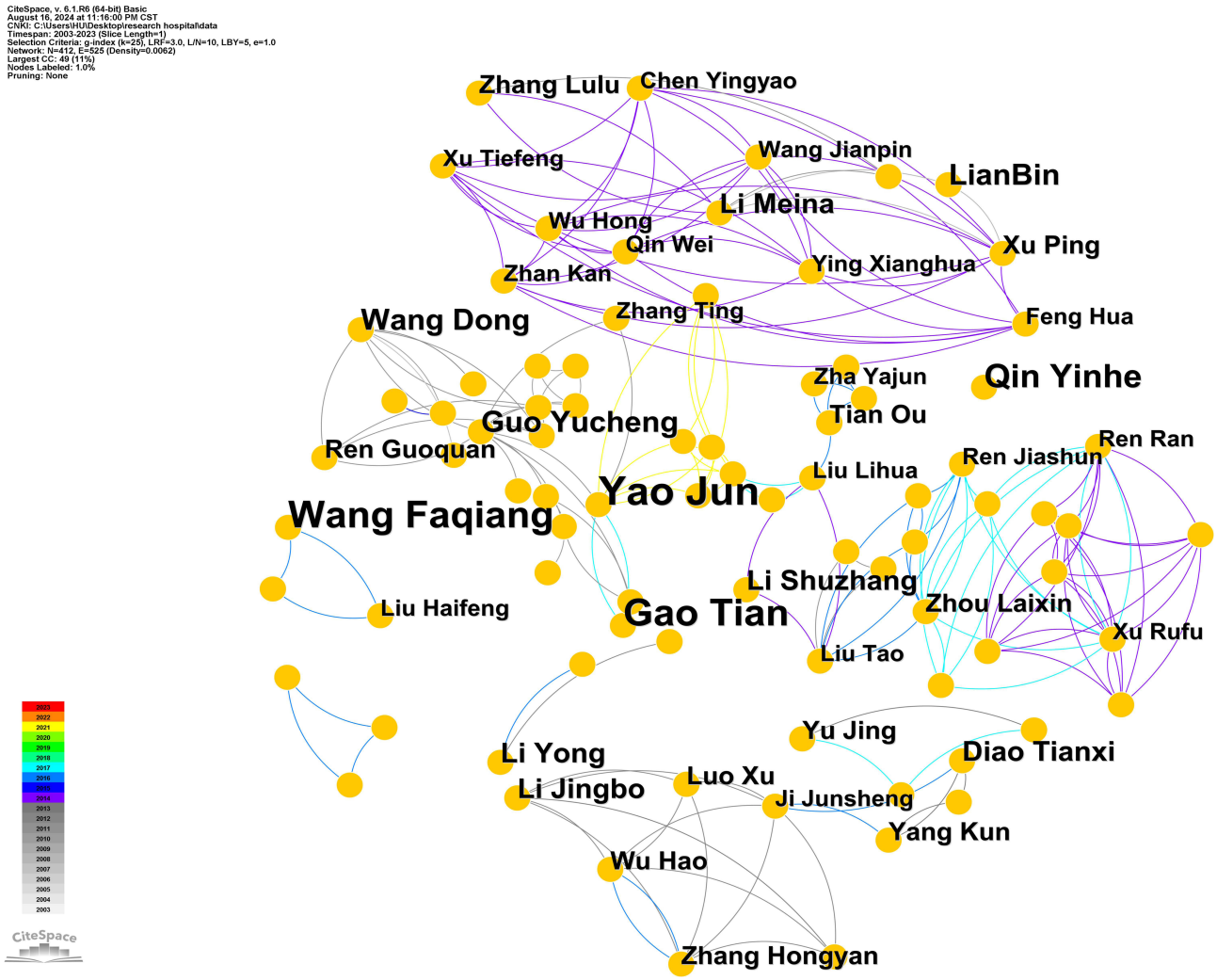

Figure 3 Collaboration network of authors.

clinical research activities, encompassing crucial medical research regions like the Beijing-Tianjin-Hebei region and the Yangtze River Delta. Overall, The cooperation model between these institutions has both advantages and disadvantages for the development of research-oriented hospitals. On one hand, collaboration between institutions means that they can achieve knowledge sharing and resource pooling among themselves. The concentration in economically prosperous regions suggests access to greater funding and advanced infrastructure, which can accelerate research breakthroughs and technological advancements. On the other hand, the overall dispersion across the network may necessitate enhanced communication strategies and coordination mechanisms to fully harness the potential of collaborative efforts.

Table 3 Top Rank Institutions in the Field of Research-Oriented Hospital

Rank	Institutions	Number of publications
1	Chinese PLA General Hospital	53
2	Shuguang Hospital Affiliated to Shanghai University of Traditional Chinese Medicine	41
3	Chinese Research Hospital Association	18
4	Naval Medical University (Second Military Medical University)	12
5	Institute of Hematology & Blood Diseases Hospital, Chinese Academy of Medical Science &Peking Union Medical College	9

Figure 4 Collaboration network of institutions.

In terms of institutional types, military academies and their affiliated hospitals hold a significant position in the publication of research-oriented hospital-related literature, represented by institutions such as the Chinese PLA General Hospital and the Naval Medical University (Second Military Medical University). This prominence can be traced back to the pioneering strategic planning proposed by the Chinese PLA General Hospital in 2004 to establish a research-oriented hospital domestically. Subsequently, in 2011, the Chinese government outlined the goal of developing over one-third of its divisional-level hospitals into research-oriented hospitals during the "Twelfth Five-Year Plan", driving several military hospitals to actively explore the path toward establishing research-oriented hospitals.[30] Since then, the momentum for research-oriented hospital development has gained substantial traction within the military healthcare system. Unlike typical public hospitals, the research achievements of military hospitals have the characteristics of military-civilian integration and the combination of peacetime and wartime. They not only improve the level of diagnosis and treatment through clinical medical technology innovation, but also serve as an indispensable and important support for China's military medicine.

Additionally, TCM has been practiced in China for thousands of years and has been widely spread and used worldwide, with unique theoretical and practical methods for treating diseases. As an important carrier for inheriting and developing TCM, many TCM hospitals have proposed to build research-oriented TCM hospitals based on the concept of research-oriented hospitals, committed to improving the clinical and scientific research level of TCM. The most representative among them is the Shuguang Hospital affiliated to Shanghai University of TCM, which proposed the strategic goal of building a research-oriented TCM hospital in 2007. This institution has published numerous research articles related to the construction and development of research-oriented TCM hospitals, significantly contributing to the high-quality development of TCM research. Unlike Shuguang Hospital affiliated to Shanghai University of TCM, Chongqing TCM Hospital, which is situated in the central region of China, is also committed to building itself into a research-oriented TCM hospital. This hospital has been selected for the "Research-Oriented Hospital Construction Unit" list released by the CRHA. In April 2024, it established the Chongqing TCM Translational Medicine Center,

dedicated to driving the leap of TCM translational medicine in central and western China. The journey of research-oriented TCM hospital exemplifies the global aspirations and local initiatives that are collectively shaping the future of TCM. Their efforts are pivotal in ensuring that the wisdom of ancient Chinese medicine continues to evolve and thrive in the modern world.

Another point worth noting is that many research-oriented hospitals are affiliated hospitals of well-known universities. Currently, the representatives of research-oriented hospitals that are widely recognized in the Chinese industry include the Beijing-based Chinese Academy of Medical Sciences & Peking Union Medical College, the West China Hospital of Sichuan University in Chengdu, the First Affiliated Hospital of Sun Yat-sen University in Guangdong, the Xiangya Hospital of Central South University in Hunan, and the First Affiliated Hospital of Zhejiang University School of Medicine in Zhejiang, among others. In the 2023 evaluation selection results of Chinese research-oriented hospitals, the general hospitals such as the West China Hospital of Sichuan University, the Chinese PLA General Hospital, and Zhongshan Hospital affiliated to Fudan University ranked in the top three nationwide with high scores.[40] It is evident that research-oriented hospitals in China are essentially partnered with and led by renowned research universities, that is, they are university-based. This is due to the inherent characteristics that require them to "fulfill clinical medical tasks while also focusing on the cultivation of medical talents and the conduct of scientific research work". The ultimate goal is to achieve a complementary relationship between scientific research and clinical practice, and to continuously promote health collaboration as well as the efficient delivery of integrated health services to the public.

Keywords Analysis

Keywords play a crucial role in representing the core content of an article.[36] Through visualizing and analyzing keyword frequencies, we can systematically and comprehensively grasp the major research hotspots and current status in the field in recent years. Co-occurrence frequency intuitively shows the number of times a specific keyword appears in the literature. The higher the frequency, the higher the research interest and attention of researchers towards that topic. Meanwhile, betweenness centrality reveals the core position and importance of a keyword in the co-occurrence network. A higher value indicates that the keyword plays a more crucial role in connections. Generally, nodes with a centrality greater than 0.1 are considered key nodes in the network.[41,42]

Figure 5 showed the keyword co-occurrence network of research-oriented hospitals, which has 310 nodes and 252 links, with a network density of 0.005, indicating a certain level of correlation and interaction between these keywords. Each node is represented by a circle, with larger circles indicating higher keyword frequencies. Furthermore, the color of the node's ring indicates the different times the related literature appears; the larger the ring, the more publications from that year are associated with that color. The lines between nodes represent two keywords appearing together in the same publication, and the color of the line represents the first instance of the keywords appearing together. The colors of the nodes gradually transition from gray to purple and other cool tones to red warm tones, representing the change in time from 2003 to 2023. Among them, "Hospital Management" is the most important node, and then the "Discipline Construction" and "Translational Medicine".

Based on the frequency and centrality of keywords, the top 10 keywords are shown in Table 4, representing the research hotspots and the core topics in the research field. The frequency of the keyword "Translational Medicine" reaches 24 times, which also has the highest centrality. The keywords with high frequency include hospital management and discipline construction, while the keywords with high centrality include technological innovation and discipline construction.

To further understand the relationship and structural characteristics among these keywords, cluster analysis was carried out. Cluster analysis identifies closely related keywords and groups them into different clusters, revealing the intrinsic logic and associations between keywords. As demonstrated in Figure 6, the log-likelihood ratio (LLR) method identified 8 major keyword clusters. Different color blocks represent different cluster regions, and a smaller cluster number indicates a larger cluster size, meaning it contains more keywords. The keyword cluster network has a Modularity value of 0.803 and a Mean Silhouette value of 0.957, indicating a significant and coherent cluster structure within the research domain.[43] Table 5 displayed the 5 main keywords included in them.

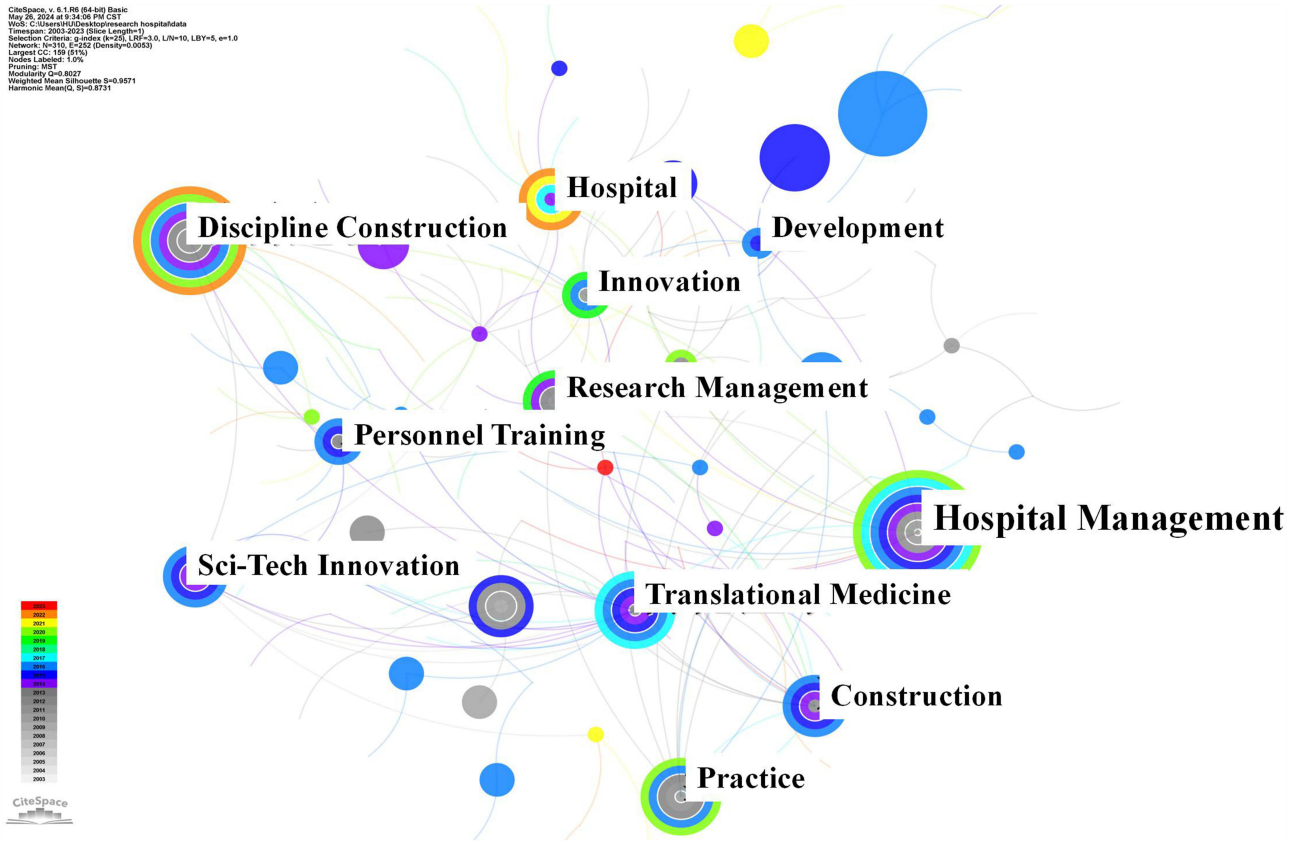

Figure 5 Keyword co-occurrence network map.

Cluster 0 is characterized as "Translational Medicine", with a focus on technology and innovation as the central themes. This cluster underscores the significance of translational medicine to research-oriented hospitals, as it represents an important manifestation of the research-oriented medical mode, playing a crucial role in the construction and development of research-oriented hospitals. The relationship between translational medicine and research-oriented hospitals is mutually beneficial; as hospitals prioritize research and innovation, they simultaneously contribute to the advancement of translational medicine.[44] This creates a dynamic ecosystem where clinical practices are informed by the latest scientific developments, and ongoing research is driven by real-world medical challenges. Overall, the identification and exploration of this cluster reveal the vital importance of integrating translational medicine into the operational frameworks of research-oriented hospitals.

Table 4 Top 10 high-Frequency Keywords

No.	Frequency	Centrality	Keywords
1	24	0.16	Translational Medicine
2	23	0.08	Hospital Management
3	22	0.09	Discipline Construction
4	17	0.08	Hospital
5	15	0.08	Innovation
6	15	0.06	Practice
7	14	0.07	Construction
8	13	0.12	Sci-Tech Innovation
9	11	0.04	Research Management
10	11	0.03	Personnel Training

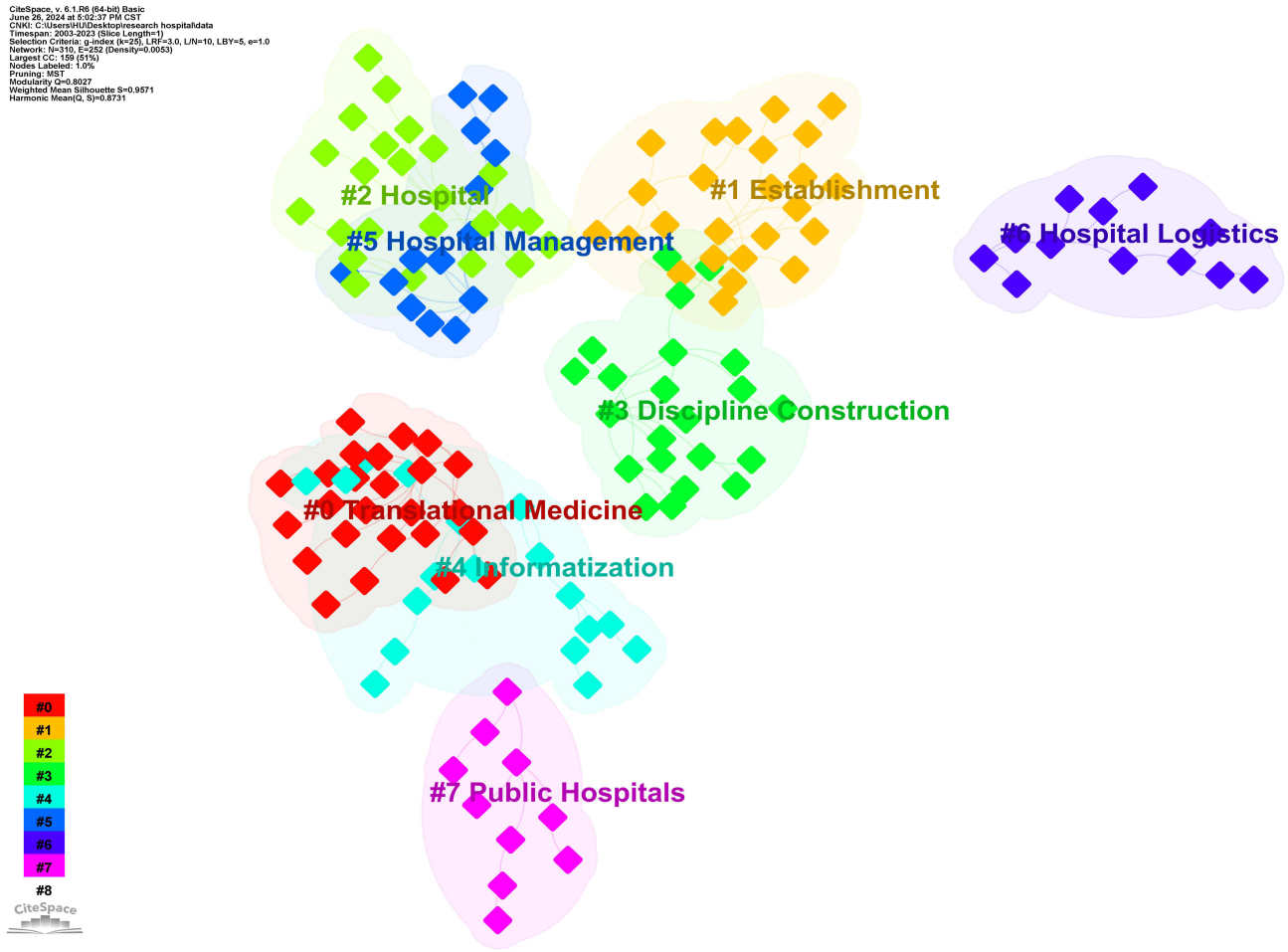

Figure 6 Keyword clusters map.

Cluster 1 is designated as "Establishment" with a diverse range of key terms including practical experiences, development strategies, management models, and impact assessments. This cluster aims to provide theoretical and practical guidance for the sustainable and robust development of research-oriented hospitals by exploring various aspects related to their establishment. Within this cluster, the focus on practical experiences highlights the importance of learning from existing case studies and best practices in establishing and operating a research-oriented hospital. Additionally, development strategies within this cluster delve into the various pathways that hospitals can take to foster a research-oriented environment. The publications related to management models can support the establishment of research-oriented

Table 5 Details of Keyword Clusters

Number	Label	5 Main Keywords
0	Translational Medicine	Translational Medicine, Sci-Tech Innovation, Development Strategy, Technological Innovation, Technology
1	Establishment	Practice, Development, Management, Establishment, Effect
2	Hospital	Hospital, Research, TCM Hospital, Cultivation Way, Strategic Research
3	Discipline Construction	Discipline Construction, Innovation, Research Management, Personnel Training, Discipline Assessment
4	Informatization	Informatization, Clinical Trials, Clinical Research, Medical Quality, Hospital Archives
5	Hospital Management	Hospital Management, Education, Postgraduate, Civil-Military Integration, Teaching Method
6	Hospital Logistics	Medical Ethics, Innovation Development, Operation Management, Internet Plus, Hospital Logistics
7	Public Hospitals	Public Hospitals, Specialized Hospitals, International Experience, Italy, Bibliometric Analysis

Abbreviations: PLA, Chinese People's Liberation Army; CRHA, Chinese Research Hospital Association; TCM, traditional Chinese medicine.

hospitals by exploring different organizational frameworks. Impact assessments provide a means to evaluate the effectiveness of the initiatives and strategies implemented during the establishment phase.

Cluster 2 is labeled as "Hospitals", with TCM Hospital identified as a pivotal keyword within this cluster, indicating that this cluster pays special attention to TCM hospitals. These institutions are distinctive medical facilities in China that deliver healthcare services grounded in TCM principles, while also integrating modern medical technologies. With the growing recognition of TCM's value within the broader healthcare sector, there is a pressing need to explores how these institutions can evolve and adapt to contemporary healthcare challenges. This entails investigating strategies to enhance clinical efficacy while ensuring the preservation and appropriate integration of TCM's rich heritage into modern healthcare paradigms. These keywords suggest discussions and research on the future development direction of research-oriented TCM hospitals.

Cluster 3 is identified as "Discipline Construction", which forms the cornerstone for elevating the overall medical, teaching, and research standards within hospitals. It encompasses discipline arrangement, interdisciplinary integration, and the trajectory of discipline development. By prioritizing discipline arrangement, hospitals can systematically organize their medical specialties, optimizing resource allocation and expertise utilization. Interdisciplinary integration further amplifies this effort by fostering collaboration between various fields, thereby promoting innovative solutions and comprehensive patient care. Moreover, this cluster highlights the important role of research management, talent cultivation, and discipline evaluation in promoting the process of discipline construction, ensuring that research-oriented hospitals remain at the forefront of medical advancement.

Cluster 4 is labeled as "Informatization", with keywords illustrating how research-oriented hospitals are striving to enhance clinical research, medical quality, and hospital management levels by integrating information technology and medical resources within an informationized framework. It also reflects the important role of informatization in promoting the modernization of hospital management, intelligentization of services, and scientific research innovation. For example, by adopting electronic health records, telemedicine, and big data analytics, research-oriented hospitals can ensure timely access to patient information, reduce errors, and enhance collaborative care. Furthermore, an informationized environment fosters scientific research innovation by providing researchers with access to vast datasets and analytical tools, which can accelerate the discovery of new treatments and practices.

Cluster 5 is identified as "Hospital Management", focusing on keywords such as Hospital Management, Education, Postgraduate, Civil-Military Integration, and Teaching Method. The focus on education and postgraduate training underscores the need for continuous professional development among healthcare staff, ensuring that they are well-equipped with the latest knowledge and skills to provide high-quality care. It can be seen that this cluster centers on the educational and training aspects of research-oriented hospitals, which are crucial components in their development and success.

Cluster 6 is labeled as "Hospital Logistics", highlighting keywords like Medical Ethics, Innovation Development, Operation Management, "Internet Plus", and Hospital Logistics. This cluster underscores the necessity of considering multiple factors to achieve the sustainable development of research-oriented hospitals, emphasizing the continuous optimization and enhancement of hospital operational models and service mechanisms. By addressing these diverse elements, hospitals can create an agile and responsive environment that adapts to the evolving needs of patients and the healthcare industry, ultimately leading to improved outcomes and enhanced service delivery.

Cluster 7 is designated as "Public Hospitals", shedding light on the increasing participation of public hospitals in the construction of research-oriented hospitals. By analyzing international experiences and current literature trends and hotspots, this cluster offers valuable insights and lessons for the advancement of research-oriented hospitals.

Keyword burst detection is the analysis of keywords that have a rapid increase in co-occurrence frequency during a specific period, enabling the quantification of the emergence and decline of popular keywords over time. Through the keyword burst intensity of literature, it can intuitively reflect the changing patterns and emerging trends of research hotspots in the field. The top 4 keywords with the strongest citation bursts are presented in Figure 7. The beginning of a dark blue line depicts when the keyword appears, and the red line marks the beginning and the end of the burst period. The four keywords experiencing bursts, namely "Innovation", "Development Strategy", "Translational Medicine", and "Hospitals", all emerged relatively early, with translational medicine and hospitals appearing burst at a later stage. Additionally, each of these keywords exhibited bursts lasting only 2–3 years.

Figure 7 Top 4 keywords with the strongest citation bursts.

Discussions

Research Status of Research-Oriented Hospitals

In the field of research-oriented hospitals, although the volume of past publications has been relatively modest and shows some fluctuation, recent years have seen a gradual recovery and growth in research activity, driven by favorable policies. Yao Jun from the Chinese PLA General Hospital is the most active scholar in this field, while the Chinese PLA General Hospital holds a leading position in terms of publication volume at the institutional level. However, it is worth noting that the current collaboration between different scholars and institutions is still limited, which may hinder the advancement of research topics in research-oriented hospitals. Additionally, the main research focus in this field is centered around keywords such as "hospital management", "discipline construction", and "translational medicine", and eight efficient and convincing keyword clusters have been successfully formed, demonstrating the diversity and depth of the research field.

Research Hotspot of Research-Oriented Hospitals

Through the analysis of keyword co-occurrence and keyword clustering results, research hotspots can be divided into three main themes.

The first research hotspot is the hospital development strategy at the macro level. Since the introduction of the concept of research-oriented hospitals was proposed, many cities and hospitals have integrated the establishment of such hospitals in their development plans, aiming to make greater breakthroughs in the healthcare field. Yang suggested that the overall construction strategy for research-oriented hospitals should include four main aspects: clarifying functional positioning, tracking the latest technological advancements, promoting the transformation of research outcomes, strengthening independent innovation, and focusing on quality management.[45] During the construction process, it is also essential to address key issues such as development stages, humanities construction, translational medicine, technological development, and hospital scale to ensure the sustainable development of research-oriented hospitals. In addition, Wang posited that there are three development models for research-oriented hospitals: a clinical-research integrated diagnosis and treatment model, a quality-focused and internally enhanced development model, and a data-driven and intelligent management model.[46] Each hospital should explore suitable development models based on different types and levels of development plans. Currently, the main research content includes some hospitals using strategic management methods such as SWOT analysis, PEST analysis, and Porter's Five Forces analysis model, to fully consider the internal and external environments that hospitals face, establish an overall development ideology for creating research-oriented hospitals, and formulate reasonable strategic measures.[47–49]

The second research focus is hospital management at the meso level. Keywords clusters such as "Disciplinary Construction", "Informatization", "Hospital Management", and "Hospital Logistics" belong to this category. The main research content involves sorting out and establishing hospital management systems that are suitable for research-oriented hospitals, and optimizing hospital operations through scientific management methods and tools to enhance the overall efficiency and quality of hospital management. Disciplinary construction is a crucial support for the development of research-oriented hospitals. To promote high-quality development of disciplinary construction and meet the specific requirements of research-oriented hospital construction, some studies have conducted in-depth research within particular

departments, and summarizing their experience in discipline construction.[50] Additionally, researchers have proposed an evaluation index system for disciplinary construction, which covers multiple areas such as innovation capability, talent cultivation, and scientific research achievement transformation, aiming to provide direct guidance for disciplinary construction in research-oriented hospitals.[51] Furthermore, the use of information technology provides technical support and security for the development of research-oriented hospitals. With the ongoing development of technology, information systems such as big data platforms, electronic medical record systems, and telemedicine technologies have been widely applied in research-oriented hospitals. These technologies contribute to improving the efficiency and quality of healthcare services, facilitating efficient and convenient research management, enhancing hospital management levels, and providing strong support for the sustainable development of research-oriented hospitals.[52] However, while enjoying the convenience and efficiency brought by informationization, information security issues cannot be ignored. Safeguarding patient privacy and data security has become an urgent problem to be solved.[53] These studies offer strong support for the sustainable development of research-oriented hospitals.

The third research hotspot is technological innovation at the micro-level. The technological innovation system of research-oriented hospitals includes three levels: knowledge innovation, technological innovation, and the promotion and application of knowledge and technology.[54] Technological innovation capability is a crucial indicator to measure the quality of the development of research-oriented hospitals. Therefore, researchers believe that it is necessary to take innovation-driven development strategies as an important orientation to constructing the performance assessment system of research-oriented hospitals.[55] Scholars have established an index system of technological innovation capability encompassing perspectives such as input, output, and management. This system not only helps research-oriented hospitals comprehensively assess their technological innovation capabilities but also provides strong references for them to formulate scientifically sound planning.[56] Research-oriented hospitals provide high-quality platform resources for the development and application of translational medicine, while the continuous progress of translational medicine also injects new vitality and growth points into the development of research-oriented hospitals.[57] Due to the inconsistent pace of development of research-oriented hospitals at present, there are also differences in the quality of translational medicine. Therefore, current research mostly focuses on theoretical aspects, paying attention to the intrinsic connections between research-oriented hospitals and translational medicine, the challenges during the development process, and the establishment of systemic mechanisms.[58] Furthermore, research-oriented hospitals also face challenges such as a shortage of high-level talent and difficulties in transforming scientific achievements into practical applications during the technological innovation process.[59] The existence of these issues demands that research-oriented hospitals take more proactive and effective measures in their future development processes, such as strengthening talent recruitment and training, to continuously enhance technological innovation capabilities.

Future Research Directions

After analyzing the bibliometric data in the field of research-oriented hospitals, we suggest that future investigations in this field could focus on several aspects. We hope to provide new inspiration and motivation for researchers in related fields, collectively opening a new chapter in the study of research-oriented hospitals.

In 2021, the General Office of the State Council of China issued the "Opinions on Promoting the High-Quality Development of Public Hospitals". Public hospitals create a leading role in China's healthcare system, and advancing their high-quality development is an inevitable choice for achieving the modernization of China's healthcare security. Establishing research-oriented hospitals is not only an effective means to promote the high-quality development of public hospitals but also an important indicator of such development. In recent years, research-oriented hospitals have garnered significant attention from scholars, resulting in a number of fruitful research outcomes. However, there is no unified consensus among Chinese scholars regarding the exact concept and essence of research-oriented hospitals. And no official documents from the government have been found that clearly define research-oriented hospitals. This has led to research focusing on conceptual analysis and theoretical framework construction, resulting in conclusions that often remain limited to theoretical discussions and case analysis, resulting in a lack of practical guidance and comprehensive exploration. Therefore, scholars should engage in interdisciplinary collaboration to conduct in-depth studies of successful experiences and best practices of research-oriented hospitals both domestically and internationally. They should

scientifically define the core characteristics and development paths of research-oriented hospitals in light of China's national conditions and healthcare system characteristics, unify the definition, connotation, and evaluation standards of research-oriented hospitals across China, and provide clear guidance for the practice of research-oriented hospitals through the issuance of policy documents or expert consensus.

In the consensus among scholars and hospital managers, research-oriented hospitals occupy a top-tier position within the healthcare service system. They primarily engage in the diagnosis and treatment of complex and critical illnesses, the development of new technologies and services, clinical research, and the translation of research outcomes. This necessitates a distinction from clinical hospitals, which are mainly responsible for treating common and frequently occurring diseases, endemic diseases, and specialized complex conditions.[55] This implies that not all medical institutions need to evolve into research-oriented hospitals; rather, hospitals that meet the requirements for becoming research-oriented should develop in a targeted manner based on their own characteristics, resources, and capabilities. This is crucial for promoting the diversification of medical institutions in China. To facilitate the effective establishment of research-oriented hospitals, we recommend that hospital managers and researchers develop and implement targeted support strategies tailored to the unique needs of different hospitals. This will further enrich research on macro-level hospital development strategies and meso-level hospital management strategies, ensuring that research-oriented hospitals can accurately position themselves, operate efficiently, and continuously lead the innovative development of the healthcare service system. Empirical studies examining the barriers to and facilitators of adopting a research-oriented model in various healthcare settings could provide invaluable insights. Such research endeavors will not only advance theoretical understanding but also enhance practical guidelines to ensure the effective implementation of research-oriented hospital frameworks across diverse healthcare environments.

From the meaning of research-oriented hospitals and the clustering of keywords, it is evident that innovation and research are the core concepts of research-oriented hospitals and also the driving force behind their sustainable development. Although this goal is widely recognized, numerous challenges still exist in reality. For instance, clinicians are often hindered by heavy clinical workloads, leaving insufficient time for exploratory research activities. Additionally, hospitals lack dedicated research-oriented physicians and the construction of professional research teams, and there are issues such as the relatively underdeveloped clinical research platforms, which restrict the depth and breadth of research. More critically, the connection between medical institutions and enterprises is not smooth enough, leading to low efficiency in the transformation of research outcomes.[60] Therefore, future research could focus more on how to address the challenges faced by research-oriented hospitals in terms of technological innovation and achievement transformation. For example, researchers should consider how to build a comprehensive policy support system, including funding support and optimizing research management policies; explore the cooperation models between medical institutions and technology enterprises, including mechanisms for technology transfer, outcome transformation, and joint research, to promote the rapid transformation and application of research results; and within hospitals, conduct an in-depth analysis of the factors that hinder physicians from engaging in scientific research and propose appropriate improvement measures. Through specific research, we can better promote research-oriented hospitals in achieving their goals of technological innovation and achievement transformation.

Study Implication

By identifying the most relevant sources of information cited in the field of research-oriented hospital, this study serves as a gateway for diverse stakeholder groups—including policy makers, hospital managers, scholars, and personnel related to pharmaceutical companies—to tap into the vital knowledge bases or further enrich their understanding of the research-oriented hospital. For policy makers and hospital managers, the insights garnered from this study illuminate both the advancements and gaps in the field, enabling them to steer decision-making processes pertinent to the establishment and enhancement of research-oriented hospitals. The prominence of keywords such as translational medicine and technological innovation, alongside the hurdles encountered by research-oriented hospitals in conducting cutting-edge research, underscores the need for governmental entities to prioritize the improvement of policy environment and incentivize investments in research and development (R&D) as well as technological infrastructure. Simultaneously, hospital managers are encouraged to refine their management systems to foster a thriving ecosystem for the translation of scientific researches into practical applications. The findings of this study present a comprehensive framework for policy makers and hospital managers, aiming to navigate

the challenges and harness the opportunities inherent in the construction and development of research-oriented hospitals. For researchers, this study provides invaluable insights by mapping out prevalent research keywords and clusters, which can serve as a roadmap for planning future research directions. By recognizing areas within research-oriented hospitals that are understudied, researchers have the opportunity to fill these knowledge gaps or delve deeper into specific topics of interest. For instance, the analysis reveals a scarcity of research focusing on the conceptual framework of research-oriented hospitals. This observation can inspire researchers and funding agencies to prioritize investigations in this domain. In summary, this study is relevant for policy makers, hospital managers, and researchers, as it can provide guidance and inspiration and promote the research-oriented hospitals' healthy development and sustainability.

Conclusions

Although to this day, the use of CiteSpace software to conduct bibliometric analysis is not a novelty worldwide, the undertaking of this study still offers innovative contributions in the field of research-oriented hospitals that previous similar studies could not match: First, by systematically reviewing the existing literature, this study summarizes the current state and development trends, enabling researchers, especially international scholars, to quickly understand the development and research trends of research-oriented hospitals in China over the past 20 years. Secondly, this study provides a beneficial supplement to previous similar literature, particularly by updating the literature database that has not been systematically bibliometrically analyzed since 2017 in terms of time span.

From 2003 to 2023, influenced by policies and economic backgrounds at different stages, the number of articles in research-oriented hospitals has four different stages of development. In the past 20 years, although the connections between authors and research institutions in academic exchange and cooperation has been limited, the research content related to research-oriented hospitals has become increasingly rich, mainly focusing on three themes: hospital development strategy, hospital management, and technological innovation. Looking ahead to the future, research in the field of research-oriented hospitals needs to continue to deepen. It is not only necessary to strengthen attention to theoretical research and practical exploration, but also to strive for the connotation construction and technological innovation capability enhancement of research-oriented hospitals. In summary, the development of research-oriented hospital theory and related practices is still in its early stages in China, but it also has enormous potential for development. Therefore, for decision-makers, hospital managers, and researchers, they can grasp the development trajectory of this field through this research and promote the deep integration of research-oriented hospital theory and practice by strengthening cross institutional and interdisciplinary academic exchanges and cooperation.

In China's healthcare system, research-oriented hospitals serve not only as providers of medical services but also as the leaders in medical science and technology innovation. From a global perspective, on the one hand, the progress of Chinese research-oriented hospitals will further enhance the influence of Chinese medical institutions within the global medical landscape. For instance, in 2016, only one Chinese healthcare institution—the West China Hospital of Sichuan University—featured in the Top 100 list of the global natural index of healthcare institutions, ranking 69th. By 2024, 25 Chinese healthcare institutions were included, and the highest ranking of West China Hospital of Sichuan University rose to 14. This illustrates the robust capabilities and rapid advancements of China in the field of medical research.[13] On the other hand, the construction of research-oriented hospitals in China is poised to have a profound impact on the global healthcare landscape. Firstly, research-oriented hospitals not only promote the international exchange and integration of medical technology and service mode by providing high-quality international medical services, but also strive to continuously narrow the gap between themselves and the international top level and further promote the overall improvement of global medical services through transnational cooperative research, academic exchanges and personnel training. Secondly, as we have repeatedly stressed, research-oriented hospitals attach great importance to health technology and innovation. Under the influence of multiple factors such as market demand and industrial policies, the development of China's research-oriented hospitals will definitely drive the prosperity of the international healthcare industry, including international cooperation and innovative development in medical devices, biomedicine, health management and other related fields, and inject new vitality into the diversified and sustainable development of the global medical industry.[61]

This study also has certain limitations. While it is grounded in the Chinese concept of "research-oriented hospitals" and conducted a comprehensive search within Chinese databases, it is acknowledged that similar concepts or practices may exist globally, and relevant literature on the same subject is widely distributed across other international databases. By concentrating solely on research topics within China, the study risks overlooking diverse perspectives and insights that could emerge from a broader literature review. This limitation could potentially skew the findings and interpretations, as they may not fully represent the global landscape of research-oriented hospitals. Future studies could broaden the scope by including multiple databases for literature comparison to minimize research bias. Additionally, in the keyword analysis, some keywords may not convey their actual meaning literally, but the lack of apparent meaning does not imply that the literature associated with these keywords lacks significance. The limitation of this visualization method lies in its inability to effectively explore the underlying literature behind these keywords, which requires further research to find alternative investigative methods. In summary, future efforts should focus on broadening data sources to include international literature, enhancing the volume of textual statistics, and utilizing more precise and advanced data analysis software.

Funding

This research was supported by Sanming Project of Medicine in Shenzhen [No.SZSM202111001] and Health Economics Association of Guangdong Province [No.2023-WJMZ-38].

Disclosure

The authors report no conflicts of interest in this work.

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