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World J Methodol 2023 September 20; 13(4): 166-372



EDITORIAL

- 166 Importance of methodological considerations in documenting psychological trauma
Vyshka G, Elezi F, Mana T

OPINION REVIEW

- 170 ChatGPT in action: Harnessing artificial intelligence potential and addressing ethical challenges in medicine, education, and scientific research
Jeyaraman M, Ramasubramanian S, Balaji S, Jeyaraman N, Nallakumarasamy A, Sharma S

REVIEW

- 179 Compensated liver cirrhosis: Natural course and disease-modifying strategies
Kumar R, Kumar S, Prakash SS
- 194 Telemedicine in inflammatory bowel diseases: A new brick in the medicine of the future?
Gravina AG, Pellegrino R, Durante T, Palladino G, D'Onofrio R, Mammone S, Arboretto G, Auletta S, Imperio G, Ventura A, Romeo M, Federico A

ORIGINAL ARTICLE**Basic Study**

- 210 Utilization of online systems to promote youth participation in research: A methodological study
Salem M, Pollack L, Zepeda A, Tebb KP
- 223 Comprehensive analysis of cell-extracellular matrix protein Ras suppressor-1 in function and prognosis of gastrointestinal cancers
Xu Y, Hou YY, Wu Z, Fang ZX, Wu HT, Liu J

Retrospective Cohort Study

- 238 Role of the phase angle in the prognosis of the cirrhotic patient: 15 years of follow-up
Pinto LP, Marroni CA, Czermainski J, Dahlem MLF, Carteri RB, Fernandes SA

Retrospective Study

- 248 Association of carbon monoxide poisonings and carboxyhemoglobin levels with COVID-19 and clinical severity
Coskun A, Demirci B, Turkdogan KA

Observational Study

- 259 External validation of the Moroccan Arabic version of the European Organization for Research and Treatment of Cancer colorectal (CR29) module: Monocentric study
Bachri H, Essangri H, El Bahaoui N, Benkabbou A, Mohsine R, Majbar AM, Souadka A

- 272 Biliary fistula and late recurrence of liver hydatid cyst: Role of cysto-biliary communication: A prospective multicenter study

Habeeb TAAM, Podda M, Tadic B, Shelat VG, Tokat Y, Abo Alsaad MI, Kalmoush AE, Nassar MS, Mustafa FM, Morsi Badawy MH, Sobhy Shaaban M, Mohamed TZ, El Sayed Henish MI, Elbelkasi H, Abdou Yassin M, Mostafa A, Ibrahim A, A-Abdelhady W, Elshahidy TM, Mansour MI, Moursi AM, Abdallah Zaitoun M, Abd-Allah ES, Abdelmonem Elsayed A, S Elsayed R, M Yehia A, Abdelghani A, Negm M, Abo-Alella HA, Elaigy MM

Prospective Study

- 287 Role of endoscopic ultrasound and endoscopic ultrasound-guided tissue acquisition in diagnosing hepatic focal lesions

Okasha HH, Delsa H, Alsawaf A, Hashim AM, Khattab HM, Abdelfatah D, Abdellatef A, Albitar A

SYSTEMATIC REVIEWS

- 296 Post-COVID-19 cholangiopathy: Systematic review

Rasheed MA, Ballotin VR, Bigarella LG, Soldera J

- 323 Potential long-term neurological and gastrointestinal effects of COVID-19: A review of adult cohorts

Sherif ZA, Deverapalli M, Challa SR, Martirosyan Z, Whitesell P, Pizuorno AM, Naqvi Z, Tulloch IK, Oskrochi G, Brim H, Ashktorab H

SCIENTOMETRICS

- 337 Physician-scientists or celebrities? Kardashian-index of gastroenterologists

Ugonabo O, Malik SU, Akbar UA, Zamani Z, Frandah W

- 345 Mapping research trends of transarterial chemoembolization for hepatocellular carcinoma from 2012 to 2021: A bibliometric analysis

Zhang N, He XF, Niu XK

CASE REPORT

- 359 Clinical, imaging, arthroscopic, and histologic features of bilateral anteromedial meniscofemoral ligament: A case report

Luco JB, Di Memmo D, Gomez Sicre V, Nicolino TI, Costa-Paz M, Astoul J, Garcia-Mansilla I

- 366 Sclerotic marginal zone lymphoma: A case report

Moureiden Z, Tashkandi H, Hussaini MO

ABOUT COVER

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The primary aim of *World Journal of Methodology* (*WJM*, *World J Methodol*) is to provide scholars and readers from various fields of methodology with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJM mainly publishes articles reporting research results obtained in the field of methodology and covering a wide range of topics including breath tests, cardiac imaging techniques, clinical laboratory techniques, diagnostic self-evaluation, cardiovascular diagnostic techniques, digestive system diagnostic techniques, endocrine diagnostic techniques, neurological diagnostic techniques, obstetrical and gynecological diagnostic techniques, ophthalmological diagnostic techniques, otological diagnostic techniques, radioisotope diagnostic techniques, respiratory system diagnostic techniques, surgical diagnostic techniques, *etc.*

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Mapping research trends of transarterial chemoembolization for hepatocellular carcinoma from 2012 to 2021: A bibliometric analysis

Na Zhang, Xiao-Feng He, Xiang-Ke Niu

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Abstract

BACKGROUND

Hepatocellular carcinoma (HCC) is the fifth most common cancer worldwide and the second leading cause of cancer-related deaths. Transcatheter arterial chemoembolization (TACE) is a therapy where drugs aimed to slow or halt tumor development are injected into the artery supplying for HCC tissues. A comprehensive analysis of all the articles on TACE for HCC can give us a general understanding of the progress in this field and provide guidance for future research.

AIM

To analyze and visualize scientific results and research trends in TACE treatment for HCC.

METHODS

The "Web of Science" database was used to identify articles regarding TACE for the treatment of HCC from 2012 to 2021. VOSviewer and CiteSpace were used to analyze the publications trends, collaboration between countries/institutions/authors, and the co-occurrence of keywords, keyword bursts, and references.

RESULTS

A total of 5728 original articles on TACE for HCC were retrieved. Regarding the volume of publications, the total number of yearly publications showed a generally increasing trend. China had the highest number of articles, while the United States achieved the highest Hirsch index and highest number of citations. The Sun Yat-sen University in China was most prolific institution. The most active author was Park, J.W from South Korea. The Journal of Vascular and Interventional Radiology (234 articles) was the most productive journal. There is a growing trend toward international collaboration in TACE for HCC. Cluster networks of co-cited references suggested that practice guidelines and targeted therapies are an essential theme in this field. In addition, cluster analysis based on keyword co-occurrence identified the research topic "prediction of TACE treatment" as a hotspot, and propensity score matching can be used to help investigators conduct innovative studies in the future.

CONCLUSION

The results of our bibliometric analysis provide the latest trends and hot topics in TACE therapy for HCC.

Key Words: Transarterial chemoembolization; Hepatocellular carcinoma; VOSviewer; CiteSpace; Bibliometrics

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Core Tip: Transarterial chemoembolization (TACE) has been considered the standard of care for intermediate stage hepatocellular carcinoma (HCC). Bibliometric analysis assesses the scientific activity in a given field. Based on the assessment of database and literature characteristics, bibliometrics can estimate developing trends in a scientific manner and expose research frontiers to researchers. Knowledge of the literature in TACE treatment for HCC can lead to a better understanding of the research trends in the field. The results of this bibliometric analysis provided the updated trends and hot topics in TACE treatment of HCC.

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INTRODUCTION

Hepatocellular carcinoma (HCC) is the fifth most common cancer worldwide and the second leading cause of cancer-related deaths[1]. Approximately 70% of patients with HCC are diagnosed at an intermediate to advanced stage, when curative treatment is no longer feasible[2]. Conventional transarterial chemoembolization (cTACE) is performed by injecting chemotherapeutic agents and lipiodol emulsion through a catheter into the tumor supply artery under the guidance of medical imaging, followed by the injection of gelatin sponge particles to embolize the tumor vessel[3]. According to the current guidelines[4,5], TACE is the recommended first-line treatment for patients with Barcelona Clinic Liver Cancer stage B (BCLC-B) disease, defined as a multinodal tumor burden, preserved liver function and good performance status.

Recent advances in TACE techniques, such as the well-known drug-eluting bead TACE (DEB-TACE), have demonstrated the potential to improve the overall survival of patients with intermediate to advanced HCC[6,7]. Studies on the combination of TACE with other treatment modalities, such as thermal ablation[8], radiotherapy[9] or systemic therapy[10], have been actively conducted and have achieved encouraging results. A comprehensive analysis of all the articles on TACE for HCC can give us a general understanding of the progress in this field and provide guidance for future research.

Bibliometric analysis assesses the scientific activity in a given field[11]. Based on the assessment of database and literature characteristics, bibliometrics can estimate developing trends in a scientific manner and expose research frontiers to researchers[12]. In recent decades, a large number of bibliometric analyses have been utilized in the medical field[13]. However, comprehensive bibliometric studies on TACE for HCC are still lacking. Therefore, the aim of this study was to systematically analyze studies on TACE for HCC to determine its current status and assess future trends.

MATERIALS AND METHODS

Data sources and search strategies

Ethics Committee approval was not required for this study as it did not involve intervention or data collection in animal or clinical trials. Articles were obtained from the Web of Science (WoS) with a time limit of January 1, 2012 to December 30, 2021, using the following search terms: TS = (Hepatocellular Carcinoma OR HCC OR Liver Cancer OR Liver

Neoplasms OR Hepatic Neoplasms OR Cancer of Liver) AND TS = (Chemoembolization OR Chemoembolisation OR Transcatheter Embolization OR Transcatheter Chemoembolization OR TACE OR Transarterial chemoembolization). Inclusion criteria included: articles from peer-review journals; written in English. We also excluded reports, books or book chapters, conference proceedings, dissertations, theses, expert opinion, commentaries, editorials, and letters. We excluded 102 studies from the list after removing duplicates because they failed all inclusion criteria or met at least one exclusion criterion. The complete screening process is shown in [Table 1](#).

Data collection

Two reviewers selected the articles independently, and any discrepancy was solved through discussion. We used the bibliometric method, VOSviewer 1.6.13 and CiteSpace 5.8.R2 to identify the data, including authors, affiliations, countries/regions, journals, number of papers and citations, year of publication, Hirsch index (H index), keywords, and references. The H index is used to quantify an individual's scientific research output and measure the impact of his or her research[14]. In this study, journal impact factors (IFs) were collected from journal citation reports for 2021.

Data analysis

In this study, the following network graphs were constructed and visualized using VOSviewer: A network graph of co-cited authors and journals, and a co-occurrence analysis of keywords. According to the frequency of items appearing together, co-citation and co-occurrence analysis can reflect the relationship of the items[15]. Additionally, in the network visualization, each node represents a different item, such as author, journal, country/region, or keyword, and the different colors of the nodes indicate different classification criteria or frequency of occurrence. The size of the node represents the number of citations or occurrences, and larger nodes represent higher-level citations or occurrences[16]. The links between nodes demonstrate the relevance of the items' co-citation or co-occurrence, and the thickness of the lines represents the strength of the links.

In addition, another bibliometric software called CiteSpace is used to show new trends and developments in the scientific literature. It is multidimensional, time-shared, dynamic visual analysis software. Burst detection is used to detect abrupt changes in nodes (including authors, countries, keywords, *etc.*). In this study, we use CiteSpace 5.8.R2 to identify highly cited references and keywords with the strongest citation burst during a certain period.

RESULTS

An overview of publications

From 2012 to 2021, a total of 5728 articles from the last decade were retrieved from WoS, including 72,403 citations for the retrieved articles, with an average number of citations (Nc) per article of 20.67. The H-index for all publications was 111. [Supplementary Figure 1](#) shows the geographical distribution of the total number of papers on TACE for HCC.

Annual trend of paper publication quantity

[Figure 1](#) demonstrates the annual number of papers (Np) related to TACE for HCC. Overall, despite fluctuations over the decade, the number of annual papers increased from 440 in 2012 to 733 in 2021, while Np increased to a peak in 2021.

Analysis of the active countries, institutions and co-authors

The included studies were published in 77 countries and regions in the last decade. We ranked the 10 high-output countries for all authors according to Np ([Table 2](#)). China had the highest number of publications (2109), followed by the United States (USA) (1100) and Japan (746). According to the citation analysis, the USA had 31045 citations, followed by China (22453) and Japan (10739). In addition, the USA achieved the highest H-index (71), followed by China (61) and South Korea (49). Overall, 201 institutions contributed to this area. [Table 3](#) displays the five most productive institutions, all of them from Asian countries. Sun Yat-sen University (from China) was the most productive institution, followed by Fudan University (from China) and Seoul National University (from South Korea). [Figure 2A](#) shows the trend of global collaboration. There is extensive collaboration among active countries. China has the closest cooperation with the USA and the United Kingdom. Three countries- China, the USA and the United Kingdom-have shown more active cooperation with each other. [Figure 2B](#) shows that the organizations are also interacting very closely. Sun Yat-sen University (China) and Johns Hopkins University (USA) are the principal institutions leading collaborative research. The co-author network knowledge map provides relevant links between authors to help researchers access potential collaboration opportunities. As shown in [Figure 3](#), the top three prominent nodes include Ilovet, J. M., Lencioni R. and Kudo M.

Analysis of highly cited articles

[Figure 4](#) Lists the number of the highest local citation score (LCS) per year for the top 20 articles. The paper is written by Park, J.W in 2015 had the highest LCS of 465 and was ranked first. This is a large multicenter, multinational collaborative retrospective study published in *Liver International*. The study concluded that TACE was the commonly used in North America, Europe, China and Korea, regardless of disease stage. Most of the articles with high LCS were conducted in multicenter and international studies and focused on major issues in TACE for HCC. [Supplementary Table 1](#) shows the study characteristics of the top 10 highly cited articles. When the threshold is set at 3, most studies focused on the clinical perspective and conventional TACE-based combination therapies.

Table 1 Topic search queries and refinement procedure

Step	Results	Refinement
1	13393	TS = (Hepatocellular Carcinoma OR HCC OR Liver Cancer OR Liver Neoplasms OR Hepatic Neoplasms OR Cancer of Liver) AND TS = (Chemoembolization OR Chemoembolisation OR Transcatheter Embolization OR Transcatheter Chemoembolization OR TACE OR Transarterial chemoembolization)
2	8530	Refined by publication years: (2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021)
3	5830	Refined by document types: Articles
4	5728	Refined by languages: English

TS: Topic; HCC: Hepatocellular carcinoma; TACE: Transarterial chemoembolization.

Table 2 The top ten countries/regions with the highest productivity

Rank	Country/Region	Np	Nc	Average per item	H-index
1	China	2109	22453	13.17	61
2	United States	1100	31045	30.41	71
3	Japan	746	10739	16.03	46
4	South Korea	595	10605	19.92	49
5	Germany	371	5529	16.04	37
6	Italy	279	9252	34.27	45
7	China Taiwan	244	5330	22.84	34
8	France	190	6609	35.97	35
9	Egypt	120	969	8.72	18
10	England	106	3554	34.74	29

H-index: Hirsch index; Np: Number of papers; Nc: Number of citations.

Table 3 The top five most productive affiliations

Rank	Affiliations	Country	Np	Nc	Average per item	H-index
1	Sun Yat-sen University	China	228	4360	20.53	34
2	Fudan University	China	146	2991	21.15	27
3	Seoul national University	South Korea	112	1497	14.23	23
4	Ulsan University	South Korea	111	2033	19.51	25
5	Yonsei University	South Korea	109	2126	20.35	25

H-index: Hirsch index; Np: Number of papers; Nc: Number of citations.

Productive journals

A total of 1247 journals published articles in the field. Furthermore, we list the 10 most productive journals with their impact factors in [Table 4](#), and provide a map of the most productive journal in [Figure 5](#). According to statistics from the WoS, Journal of Vascular and Interventional Radiology ranked first with 234 publications in the last decade. Cardiovascular and Interventional Radiology ranks second (220 publications), followed by World Journal of Gastroenterology (143 publications), Medicine (118 publications), and PLoS One (113 publications).

Analysis of co-cited references

Unlike local citation analysis, co-citation networks emphasize research topics that are closely linked to a specific field. The reference co-citation relationship changes over time, and its study can explore the development and evolutionary dynamics of a particular study. [Figure 6A](#) shows the mapping of co-cited references based on TACE treatment. [Figure 6B](#) depicts the top 20 references with the strongest citation explosion. The most cited references and the highest concen-

Table 4 The top 10 most active journals

Rank	Journal	Np	Nc	Average per item	H-index	IF (2021)
1	<i>Journal of Vascular and Interventional Radiology</i>	234	3858	17.41	33	3.682
2	<i>Cardiovascular and Interventional Radiology</i>	220	2845	13.86	26	2.797
3	<i>World Journal of Gastroenterology</i>	143	3423	24.25	33	5.374
4	<i>Medicine</i>	118	1057	9.16	18	1.817
5	<i>PLoS One</i>	113	2108	18.94	26	3.752
6	<i>European Radiology</i>	108	1441	14.13	21	7.034
7	<i>Hepatology Research</i>	81	1434	18.32	21	4.942
8	<i>Frontiers in Oncology</i>	77	278	3.83	9	5.738
9	<i>Oncotarget</i>	75	1119	15.17	19	/
10	<i>BMC Cancer</i>	74	1487	20.18	23	4.638

H-index: Hirsch index; Np: Number of papers; Nc: Number of citations; IF: Impact factors.

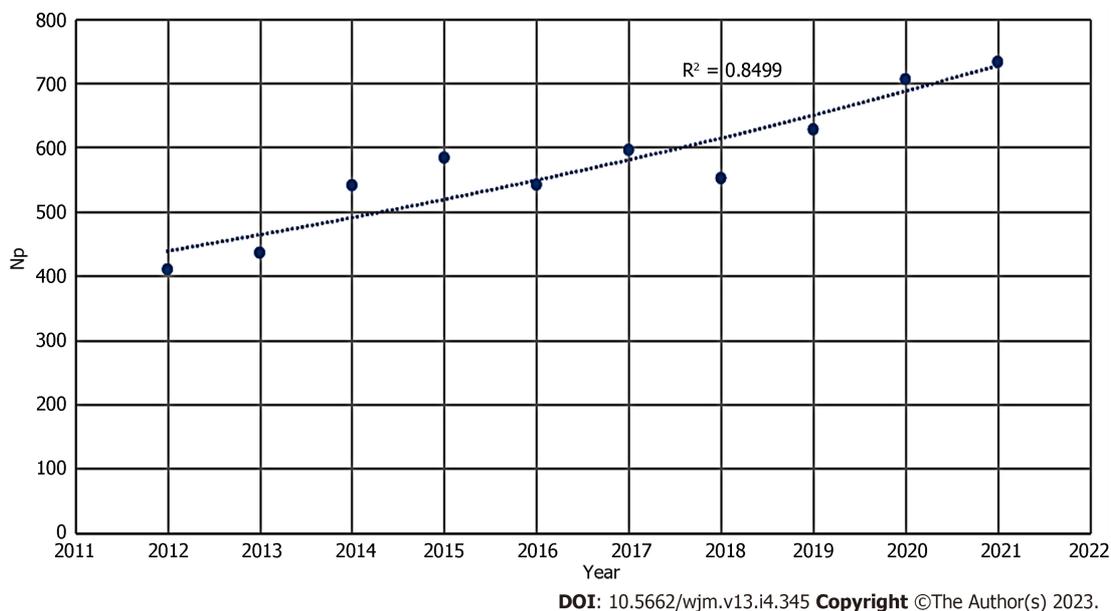


Figure 1 Curve fitting of publications' overall yearly growth trend. Np: Number of papers.

tration of TACE treatment for HCC are “practice guidelines” and “targeted therapy”.

Keywords co-occurrence analysis

The high frequency and centrality of keywords allows exploration of core issues and research hotspots of broad interest in the field. A total of 192 terms that appeared more than 20 times were grouped into five clusters. The top three clusters are as follows: Cluster 1 (red) mainly represented the prediction of TACE treatment, as shown in [Supplementary Figure 2A](#). Cluster 2 (green) is focused on vascular endothelial growth factor (VEGF) expression and tumor angiogenesis. Cluster 3 (blue) was the drug-delivery method. The top frequent occurrences of keywords were “HCC”, “survival”, “management” and “prognosis”, indicating that the main focus of research is placed on the prognosis of TACE treatment. Additionally, “drug-delivery method”, “targeted therapy” and “response assessment” have long been a focus of research in the field, as shown in [Supplementary Figure 2B](#). Additionally, we found that the propensity score matching was increasingly used to assess TACE safety/efficiency ([Supplementary Figure 2C](#)).

DISCUSSION

To the best of our knowledge, this is not the first but comprehensive bibliometric analysis of TACE management in HCC.

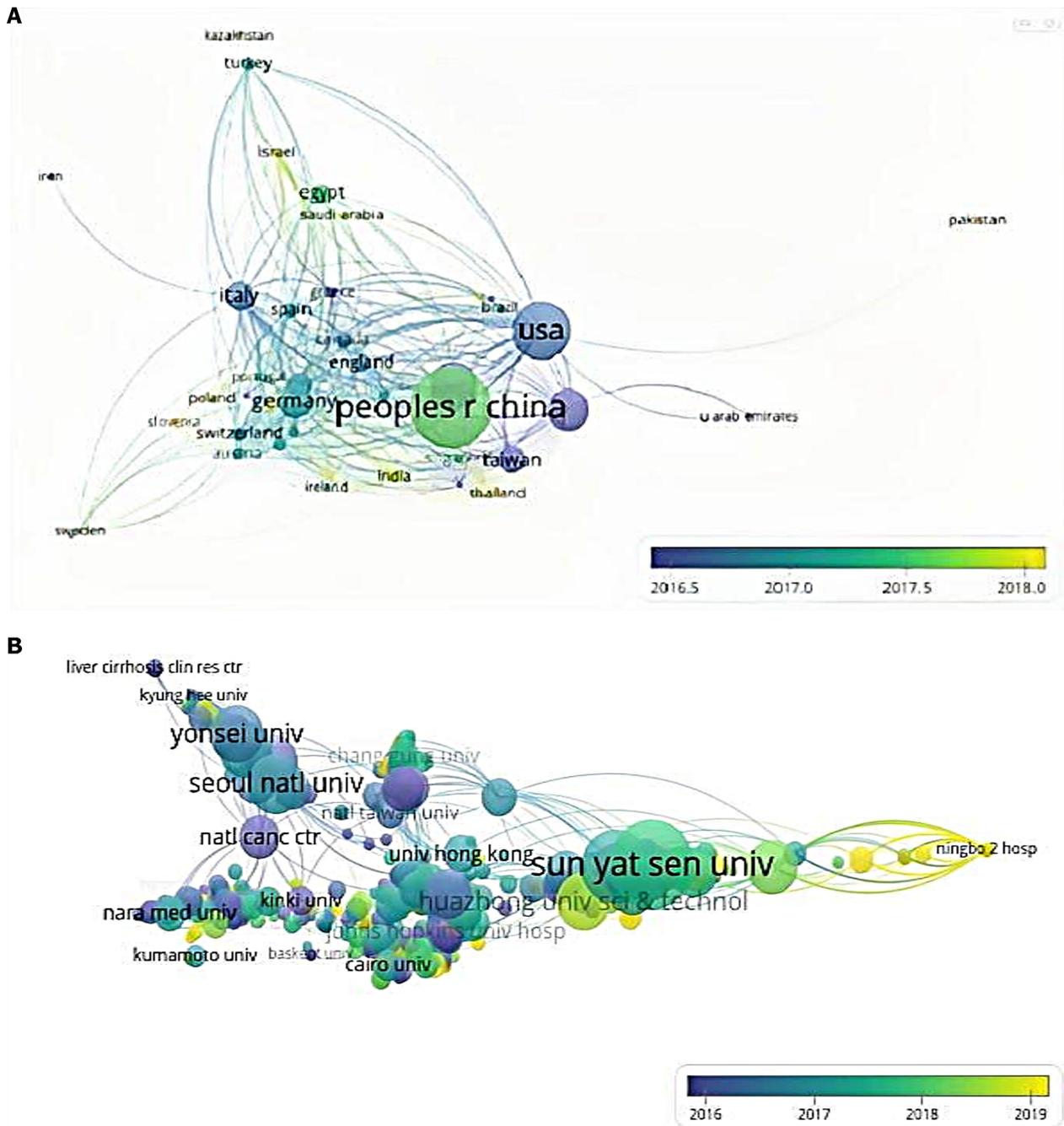


Figure 2 Shows the trend of global collaboration, the organizations are also interacting very closely. A: Mapping of the main research countries in transarterial chemoembolization (TACE) for hepatocellular carcinoma (HCC). The minimum number of documents of a country was set at 5. Of the 80 countries that were involved in this field, 42 countries met the threshold; B: Mapping of the collaboration network of the main research organizations in TACE for HCC. The minimum number of documents of an organization was set at 15. Of the 2146 organizations that were involved in this field, 74 organizations met the threshold.

A unique database was created, duplicate articles were removed and then selected articles were analyzed along different dimensions: Bibliometrics, demographics, authors, and research trends. The overall increasing trend in the number of papers from 2011 to 2021 reflects a relatively promising research future for TACE in the coming years.

Among the most prolific countries/regions, China ranked first in N_p , indicating that China is a highly productive country in this field. Two Chinese institutions and three South Korean institutions came in the top 5 affiliations in N_p . According to the GLOBOCAN database, Asia accounts for nearly 72.5% of newly diagnosed cases and 72.4% of deaths from HCC[17]. The BRIDGE study in 2015 concluded that the survival times in South Korea and China were significantly less than that in Japan, which to some extent suggests that these two countries have invested significant resources in recent years. However, compared with China, the USA had a relatively high N_c and H-index. This is because the USA is undoubtedly the most impactful in scientific research fields. The USA has been at the center of academic publishing and has been supported by significant investments in academic research and technological innovation. In recent years, China has also invested heavily in innovative embolic materials for TACE. CalliSpheres® Beads are the first drug eluting beads

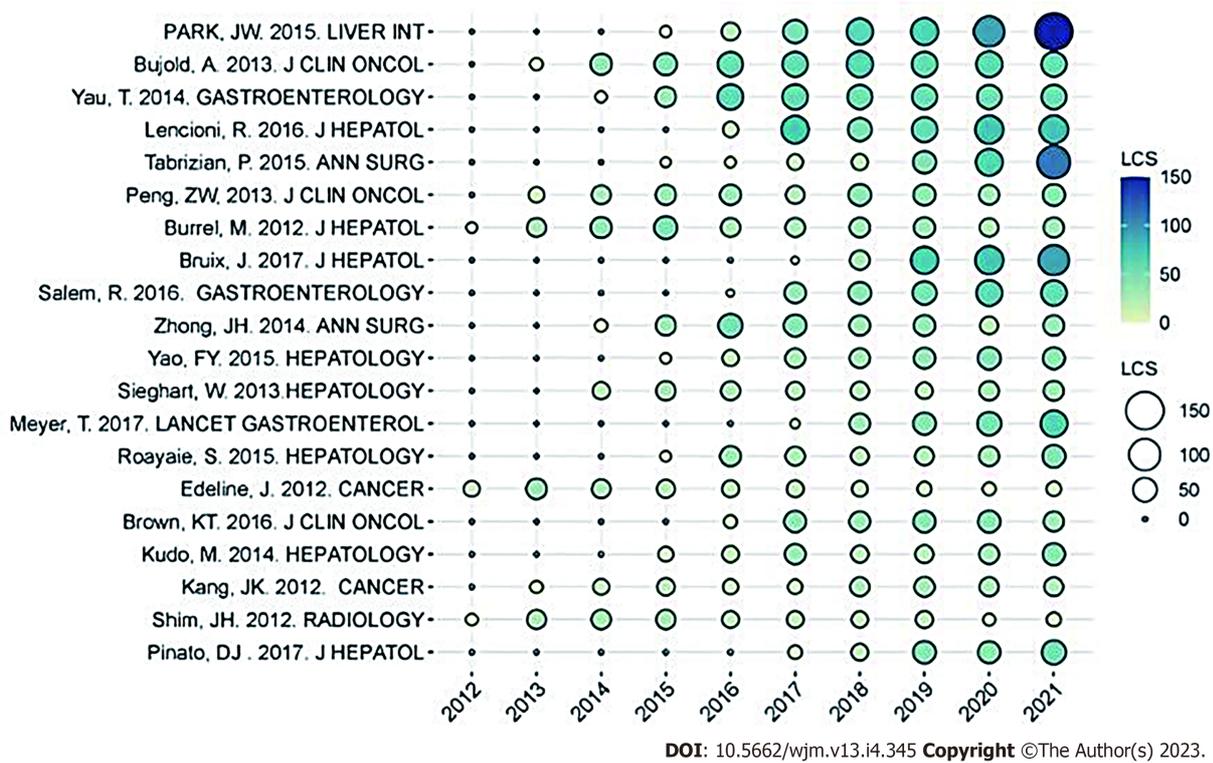


Figure 4 The yearly number of local citations of papers with high local citations. The size and colors of the circle represent the high local citations of papers. LCS: High local citations.

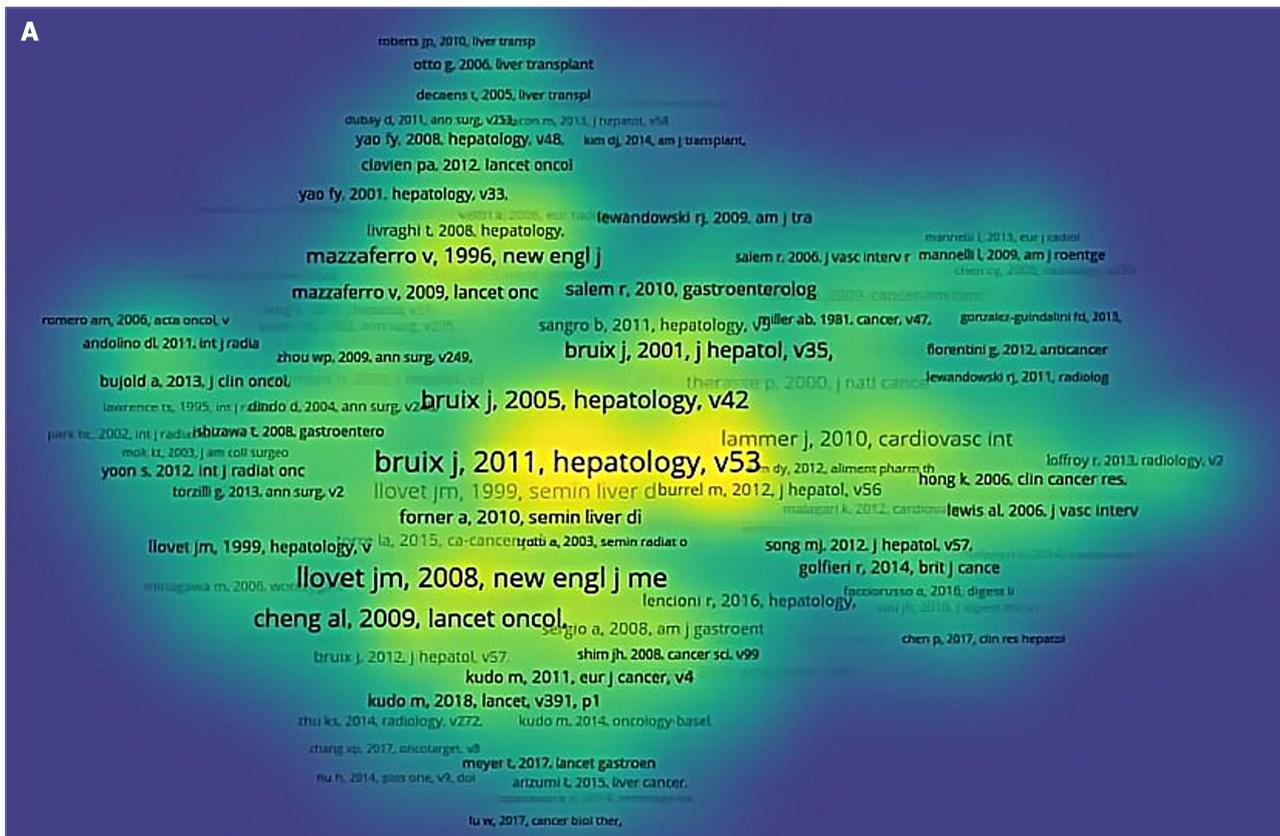
mechanisms responsible for tumor progression and treatment resistance, the sequences and timing of drug administration, and which TKI drugs are most beneficial to patient survival from combination therapy[23,24].

Some emerging research on TACE is gradually becoming a research topic. Cluster 1 (red) primarily represented the prediction of TACE treatment. TACE benefits patients survival; however, repeated TACE therapy progressively impairs liver function. Careful evaluation of the risks and benefits of repeated TACE is needed to improve the long-term outcomes of TACE for HCC. Appropriate decision support has been established during TACE treatment, including the HAP (hepatocellular artery embolization prognosis) score and its modifications (mHAP-II and -III)[25]. A recent study by Wang *et al*[26] developed an easy-to-use model, referred to as the "six-and twelve" score, which stratifies ideal TACE candidates based on the sum of tumor size and number of lesions. Unfortunately, the results of some external validation studies suggested that the model only has a modest predictive ability[27,28]. More recently, Han *et al*[29] developed a survival prediction model that assesses patients prior to initial TACE. Although good results were obtained in the preliminary study, the utility of this model needs to be evaluated in future studies. Novel artificial intelligence approaches based on imaging data clearly hold great promise for the future. A study by Niu *et al*[30] demonstrated the feasibility of a CT-based radiomics model to predict the outcome of sequential TACE treatment.

Cluster 2 is involved in VEGF expression and angiogenesis in HCC. It has been demonstrated that both tumor progression and metastasis are closely related to tumor neoangiogenesis. VEGF is one of the most important angiogenic factors and is highly expressed in HCC tumors; it is associated with tumor angiogenesis, growth, recurrence, and metastasis[31]. Thus, studies on VEGF expression and angiogenesis may lead to novel therapeutic targets for HCC, particularly, in combination with TACE for HCC. Unfortunately, the ideal candidate for molecularly targeted drugs in combination with TACE remains uncertain. Currently, there are more than 1000 clinical trials enrolling patients, demonstrating a dedication to finding novel effective systemic therapeutics or targeting immune checkpoints for the treatment of HCC[32].

In terms of the "delivery method", conventional TACE using iodine oil loaded with anticancer drugs is less effective, and although DEB, including HepaSphere, CalliSpheres and TANDEM, are used, there are still problems of low response rates, as well as chemotherapeutic drug escape and tumor resistance[33]. Currently, the combination of nanodelivery systems with TACE is of interest. Due to the method of medication, the targeting effect of TKIs is poor, while nanodelivery systems can provide an opportunity to overcome the drawbacks and achieve good results[34]. Ding *et al*[35] developed peptide nanogels with a stimulatory response for the delivery of lenvatinib with good tumor suppression and few side effects. Although some nanoparticles (NPs) have been approved by the FDA for clinical use, the safety of NPs has been an unavoidable issue during human applications. Therefore, more in-depth experimental studies and clinical trials on various combinations of TACE and nanospheres are needed to explore the correlation between NP size and optimal drug loading and their impact on drug delivery properties.

In the last decade, technical improvements, mainly include: (1) The treatment should involve a water-in-oil emulsion, which maximize the propensity to target the tumor feeding arteries[36]; (2) improvement of imaging quality during



B

Top 20 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	2012 - 2021
Lencioni R, 2010, SEMN LIVER DIS, V30, P52, DOI 10.1055/s-0030-1247132, DOI	2010	89.99	2012	2015	██████████
Llovet J, 2008, NEW ENGL J MED, V359, P378, DOI 10.1056/NEJMoa0708857, DOI	2008	81.96	2012	2013	██████████
Cheng A, 2009, LANCET ONCOL, V10, P25, DOI 10.1016/S1470-2045(08)70285-7, DOI	2009	71.62	2012	2014	██████████
Lammer J, 2010, CARDIOVASC INTER RAD, V33, P41, DOI 10.1007/s00270-009-9711-7, DOI	2010	48.86	2012	2015	██████████
Llovet J, 2008, JNCI-J NATL CANCER I, V100, P698, DOI 10.1093/jnci/djn134, DOI	2008	41.06	2012	2013	██████████
Eisenhauer E, 2009, EUR J CANCER, V45, P228, DOI 10.1016/j.ejca.2008.10.026, DOI	2009	32.85	2012	2014	██████████
Salem R, 2010, GASTROENTEROLOGY, V138, P52, DOI 10.1053/j.gastro.2009.09.006, DOI	2010	31.02	2012	2015	██████████
Bruix J, 2011, HEPATOLOGY, V53, P1020, DOI 10.1002/hep.24199, DOI	2011	128.91	2013	2016	██████████
Jemal A, 2011, CA-CANCER J CLIN, V61, P69, DOI 10.3322/caac.20107, DOI	2011	51.82	2013	2016	██████████
Forner A, 2012, LANCET, V379, P1245, DOI 10.1016/S0140-6736(11)61347-0, DOI	2012	50.18	2014	2017	██████████
European A, 2012, EUR J CANCER, V48, P599, DOI 10.1016/j.ejca.2011.12.021, DOI	2012	108.14	2015	2017	██████████
Torre L, 2015, CA-CANCER J CLIN, V65, P87, DOI 10.3322/caac.21262, DOI	2015	40.56	2016	2019	██████████
Golfieri R, 2014, BRIT J CANCER, V111, P255, DOI 10.1038/bjc.2014.199, DOI	2014	30.04	2016	2019	██████████
Ferlay J, 2015, INT J CANCER, V136, P0, DOI 10.1002/ijc.29210, DOI	2015	35.29	2017	2021	██████████
European A, 2018, J HEPATOL, V69, P182, DOI 10.1016/j.jhep.2018.03.019, DOI	2018	101.94	2019	2021	██████████
Heimbach J, 2018, HEPATOLOGY, V67, P358, DOI 10.1002/hep.29086, DOI	2018	68.85	2019	2021	██████████
Forner A, 2018, LANCET, V391, P1301, DOI 10.1016/S0140-6736(18)30010-2, DOI	2018	54.63	2019	2021	██████████
Kudo M, 2018, LANCET, V391, P1163, DOI 10.1016/S0140-6736(18)30207-1, DOI	2018	52.58	2019	2021	██████████
Omata M, 2017, HEPATOL INT, V11, P317, DOI 10.1007/s12072-017-9799-9, DOI	2017	32.98	2019	2021	██████████
Lencioni R, 2016, HEPATOLOGY, V64, P106, DOI 10.1002/hep.28453, DOI	2016	30.24	2019	2021	██████████

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Figure 6 Shows the mapping of co-cited references based on transarterial chemoembolization treatment, depicts the top 20 references with the strongest citation explosion. A: Density visualization of co-cited references. Of the 68527 references, 1159 (divided into six clusters) were cited at

least 20 times. Yellow means appearing more frequently, while green means appearing less frequently; B: The top 20 co-cited references with the most citation burstiness. Years between "Begin" and "End" represent the period when the reference was more influential. Years in light green mean that the reference has not yet appeared, years in dark green mean that the reference is less influential, and years in red mean that the reference is more influential.

CONCLUSION

In conclusion, the results of our bibliometric analysis provide the latest trends and hot topics in TACE therapy for HCC. Based on the results found by CiteSpace and VOSviewer, we can conclude that current research in this field is focused on survival prediction and TACE-based combined therapies. These results can also help researchers in the field find relevant literature and stay informed about hot topics.

ARTICLE HIGHLIGHTS

Research background

Hepatocellular carcinoma (HCC) is the fifth most common cancer worldwide and the second leading cause of cancer-related deaths. Transcatheter arterial chemoembolization (TACE) is a therapy where drugs aimed to slow or halt tumor development are injected into the artery supplying for HCC tissues. A comprehensive analysis of all the articles on TACE for HCC can give us a general understanding of the progress in this field and provide guidance for future research.

Research motivation

The bibliometric analysis can be an important tool to help quantify and evaluate productivity within a scientific field, while also providing a comprehensive overview of the literature for students, trainees and experts in addition to identifying potential future research directions.

Research objectives

The aim of this study was to systematically analyze studies on TACE for HCC to determine its current status and assess future trends.

Research methods

The "Web of Science" database was used to identify articles regarding TACE for the treatment of hepatocellular carcinoma (HCC) from 2012 to 2021. VOSviewer and CiteSpace were used to analyze the publications trends, collaboration between countries/institutions/authors, and the co-occurrence of keywords, keyword bursts, and references.

Research results

A total of 5728 original articles on TACE for HCC were retrieved. Regarding the volume of publications, the total number of yearly publications showed a generally increasing trend. China had the highest number of articles, while the United States achieved the highest Hirsch index and highest number of citations. The Sun Yat-sen University in China was most prolific institution. The most active author was Park JW from South Korea. The Journal of Vascular and Interventional Radiology (234 articles) was the most productive journal. There is a growing trend toward international collaboration in TACE for HCC. Cluster networks of co-cited references suggested that practice guidelines and targeted therapies are an essential theme in this field. In addition, cluster analysis based on keyword co-occurrence identified the research topic "prediction of TACE treatment" as a hotspot, and propensity score matching can be used to help investigators conduct innovative studies in the future.

Research conclusions

We found that current research in this field focuses on survival prediction and TACE-based combined therapies. These results can also help researchers in the field find relevant literature and stay informed about hot topics.

Research perspectives

High-quality international multicenter studies are needed to confirm how TACE-based combination therapies better improve patient survival.

FOOTNOTES

Author contributions: Zhang N and He XF contributed equally to this work; Niu XK designed the research study; Zhang N performed the research; He XF contributed analytic tools; Zhang N and Niu XK analyzed the data and wrote the manuscript; all authors have read and approve the final manuscript.

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