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Bibliometric analysis of acute pancreatitis in Web of Science database based on CiteSpace software

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Abstract

Objectives: Recent years have witnessed some controversial viewpoints in clinical and basic research, which exert a great influence on the research trend of acute pancreatitis (AP). We aimed to analyze the literature on AP by metrology, co-occurrence, co-citation, and visualization, and to explore the research status and trend in this field in the past 5 years.

Methods: The relevant literature collected in Web of Science Core Collection (WoSCC) database from 2015 to 2019 was searched using "acute pancreatitis" as the title word, and the co-occurrence analysis of authors, institutions, countries, and keywords was carried out by using CiteSpace V. On this basis, the keywords were clustered and analyzed by using VOSviewer 1.6.8 and Carrot 2 software, and a visual map was drawn.

Results: A total of 2035 articles were included, with an average annual volume of more than 400. The high-yield authors were mainly Chinese, among which Li WQ was the most prominent. Most of these articles were from universities and institutions of high-yielding countries including China, the United States, and India. The main sources of journals were professional journals, among which Pancreas and Pancreatology have the most literature collection volume (both over 100), including clinical and basic research. Among the funds, the National Natural Science Foundation of China and NIH were the main 2 sponsors. Disciplinary attributes involved multiple subjects such as gastroenterology, internal medicine, and surgery. Keyword co-occurrence and clustering results showed that the classification, mortality, and risk factors of AP were still more concerned, and the research trend of this disease was the molecular mechanism of the severity of AP.

Conclusions: CiteSpace can be used to analyze the knowledge graph of AP, to show its development status initially and intuitively, and to provide a reference for topic content and its further development.

Abbreviations: AP = acute pancreatitis, IF = impact factor, SAP = severe acute pancreatitis, WoSCC = Web of Science Core Collection.

Keywords: acute pancreatitis, CiteSpace, knowledge map, web of science

1. Introduction

With the improvement of diet structure, acute pancreatitis (AP) as a common clinical acute abdomen disease is gradually becoming a prominent problem endangering people's health. If not treated in time, it may develop into severe acute pancreatitis (SAP).[1] According to the clinical epidemiological survey, the global annual incidence of AP is 34/100,000, and this number is still on the rise.[1] Recent years have witnessed some controversial viewpoints in clinical and basic research, which exert great influences on the research trends of AP, such as whether the AP is a self-limited disease, and whether there is a causal relationship between trypsin activation and inflammation, etc.[2] These perceptions are of great significance to the in-depth study of the mechanism, so it is still necessary to make a phased summary of the study of AP. Here we mainly discuss the research status of AP in the past five years from the perspective of bibliometrics, and discuss its future research trends.

Bibliometrics is a text mining and analysis method realized by software such as CiteSpace V according to the literature information of the target subject under the environment of Java based on Web of Science Core Collection (WoSCC) and other databases.[3] CiteSpace is a kind of scientific software, which can reveal the research trends in scientific literature.[4,5] This method can calculate the corresponding data around knowledge graphs involving important information including authors, research institutions, and key words, which has been widely used in many fields such as medicine, ecology, and so on. On the basis of this method, this paper jointly used VOSviewer and Carrot, to draw the knowledge graph of global scholars around AP in the past 5 years, and discusses the research status and trend of AP from the aspects of authors, institutions, and key words, hoping to promote the research of AP.

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2. Methods

2.1. Data sources

The related literatures collected in WoSCC database from 2015 to 2019 were searched using "acute pancreatitis" as the title word. The literature database was derived from the scientific network database. Literature search was performed within one day (July 20, 2019) to avoid bias caused by daily database updates. In this study, only Articles (research articles) were included, and there were no restrictions on language and data categories. A total of 2047 articles were obtained. After the duplicate articles were removed, 2035 articles were left. (The data in this research comes from public databases, so it does not involve ethical approval.)

2.2. Statistical methods

The co-occurrence and cluster analysis of authors, research institutions, countries, funds, discipline attributes, and keywords were carried out by using CiteSpace software, and presented in the form of knowledge graph. The basic parameter settings of Citespace software were the same as those of Zhao Y.[6] On this basis, we adopted VOS viewer and Carrot software to perform cluster analysis and comparison on keywords and drew a visual map. In the network graph, different nodes represented various elements such as authors, institutions, countries, and keywords, while the size of nodes reflected the number or frequency of publications.[7] Links between nodes indicated relationships such as collaboration, co-occurrence, or co-reference.[8,9]

3. Results

3.1. Graph analysis of the author co-citation

For the included data analysis, a total of about 8900 authors have published studies on AP in the past 5 years. In the visual analysis map of the author made by Citespace (Fig. 1A), there were 196 nodes and 232 connections, and the density of the topological network in the literature was 0.0121. The top 20 high-volume authors were selected as high-yield authors, and the number of articles and the degree of centrality were taken as the 2 comprehensive evaluation indices. It can be seen from Table 1 that, 6 scholars, that is Li WQ (44), Tong ZH (30), Li JS (23), Wang XP (18), Lu GT (15), and Zhou J (15), were in the forefront in terms of publication volume and centrality, who are considered as the core and productive authors in the field of AP. In addition,

Table 1

Top 20 authors in terms of number of articles published.

No.	Frequency	Centrality	Author
1	44	0.24	Li WQ
2	30	0.15	Tong ZH
3	29	0.04	Petrov MS
4	29	0.01	Lin CL
5	23	0.43	Li JS
6	22	0.01	Papachristou GI
7	22	0.01	Lai SW
8	21	0.01	Liao KF
9	21	0.01	Yadav D
10	21	0.01	Whitcomb DC
11	20	0.01	Abu-El-Haija M
12	20	0.01	Wang WX
13	19	0.02	Pendharkar SA
14	18	0.21	Wang XP
15	18	0.08	Windsor JA
16	17	0.07	Chen Y
17	17	0.06	Li J
18	15	0.01	Sutton R
19	15	0.1	Lu GT
20	15	0.05	Li Y

it can be clearly seen from Figure 1A that, the links between different teams were relatively close, such as the Li WQ team and the Petrov MS team, which also indicates the phenomenon of core cluster of scholars.

Different from the author's analysis, the author's co-citation analysis was based on the statistics of references in the past 5 years. Figure 1B showed the visual analysis map of the author, with 98 nodes and 192 connections, and the density of the topological network in the literature was 0.0404. From Figure 1B, we can see that there was a close cooperation between authors in this field, and there were many cross-references to each other. Through the comprehensive comparison of the 2 evaluation indexes of co-citation and centrality, we can see from Table 2 that a total of 16 authors including BANKS PA were in the forefront as the core cited authors in this field.

In order to further focus on the most valuable core authors, in this paper, a cross-comparison was made between the core authors in the published author and the core authors in the co-citation. It is found that 4 scholars, Petrov MS, Papachristou GI, Yadav D, and Whitcomb DC (the red part in Table 1 and
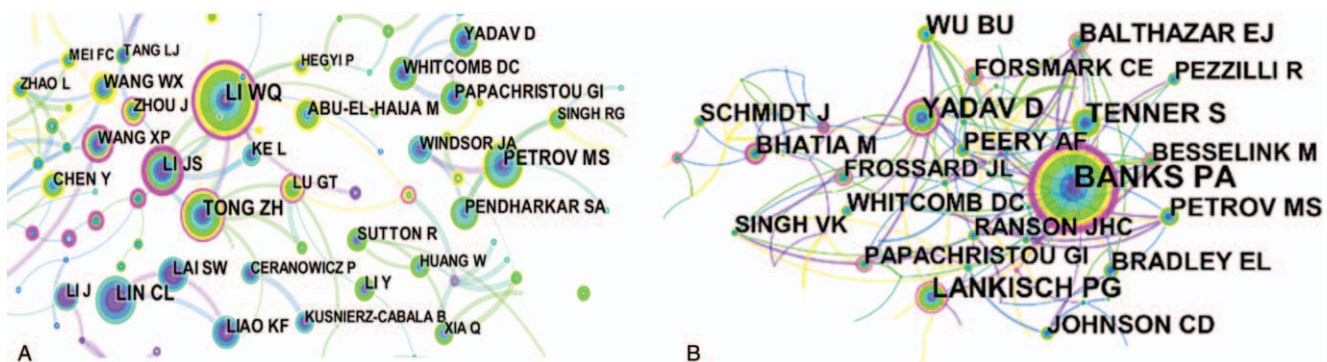
Figure 1. Relevant map of authors on acute pancreatitis. (A, Published author map; B, Co-cited author map).

Table 2

The result of author co-citation analysis.

No.	Frequency	Centrality	Author
1	751	0.76	Banks PA
2	321	0.07	Tenner S
3	311	0.33	Yadav D
4	307	0.11	Lankisch PG
5	217	0.08	Wu BU
6	208	0.04	Petrov MS
7	201	0.15	Balthazar EJ
8	184	0.02	Bradley EL
9	181	0.06	Peery AF
10	172	0.22	Bhatia M
11	165	0.07	Johnson CD
12	163	0.17	Forsmark CE
13	162	0.19	Frossard JL
14	160	0.01	Whitcomb DC
15	158	0.02	Pezzilli R
16	153	0.18	Besselink M
17	152	0.1	Papachristou GI
18	150	0.08	Ranson JHC
19	149	0.01	Schmidt J
20	118	0.01	Singh VK

Table 3

Top 20 institutions in terms of number of articles published.

No.	Frequency	Centrality	Institution
1	71	0.08	Shanghai Jiao Tong Univ
2	62	0.09	Sichuan Univ
3	47	0.01	Nanjing Univ
4	43	0.13	Univ Pittsburgh
5	42	0.01	China Med Univ
6	37	0.01	Univ Auckland
7	31	0.01	China Med Univ Hosp
8	30	0.04	Tongji Univ
9	26	0.05	Mayo Clin
10	25	0.01	Capital Med Univ
11	24	0.01	Nanjing Med Univ
12	24	0.01	Wuhan Univ
13	21	0.02	Univ Liverpool
14	21	0.01	Taichung Tzu Chi Gen Hosp
15	19	0.01	Wenzhou Med Univ
16	19	0.02	Soochow Univ
17	19	0.01	Cincinnati Childrens Hosp Med Ctr
18	19	0.01	Jagiellonian Univ
19	18	0.01	Zhejiang Univ
20	18	0.06	Cedars Sinai Med Ctr

Table 2), all appeared in the 2 maps, indicating that they played a crucial role in the study of AP.

3.2. Visual map analysis of research institutions and countries

The visual analysis of research institutions can offer scholars with more information about AP, which is more conducive to the cooperation and exchange between institutions and regions. In the visual analysis atlas of AP research institutions (Fig. 2A), there were 230 nodes and 222 connections, and the topological network density was 0.0084, which indicated that the current cooperation and communication between research institutions were more frequent, as shown in Table 3. It can be seen that Shanghai Jiao Tong University and other units were the top 10 research institutions in terms of publication volume.

From the visual analysis map of the sending countries, we can figure out the degree of attention of each country to AP and the situation of the published papers. In Figure 2B, there were 212 nodes and 217 connections, and the density of the topological network in the literature was 0.0027. As can be seen from

Table 4, countries including China, the United States, Iran, India, Turkey, and Japan were the leaders in publication volume with a large number of articles.

3.3. Map analysis of journals and co-cited journals

Table 5 lists the top 10 journals by number of publications. There were a total of 197 nodes and 204 connections in the visual analysis of the cited journals (Fig. 3A), and the density of topology network was 0.0036. It can be seen from Table 6, in co-cited journals, *Pancreas* (1217) is also ranked first, followed by *Gut* (1152), *Gastroenterology* (1071), *Pancreatology* (985), and *World J Gastroentero* (962). The impact factor (IF) of co-cited journals was generally higher than that of published journals. *New Engl J Med (70.67)* and *Lancet (59.102)* had *the* highest if in 2019, followed by *Gastroenterology (19.223)* and *Gut (17.943)*. By comparing co-cited journals with published journals, we found that: *Pancreas*, *Pancreatology,* and *World Journal of Gastroenterology* were in the forefront in terms of publication and co-citation, so they are the most important and valuable journals in this field.
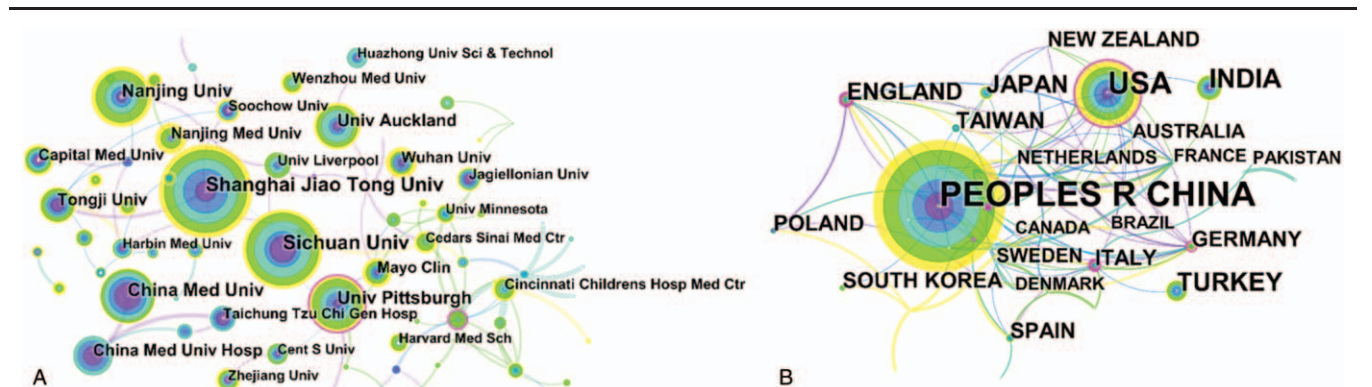

Figure 2. Visual analysis of research institutions and countries on AP. (A, Published institution map; B, Published country map).

Table 4

Top 20 countries in terms of number of articles published.

No.	Frequency	Centrality	Institution
1	691	0.08	Peoples R China
2	351	0.18	USA
3	156	0.01	India
4	134	0.01	Turkey
5	91	0.01	Japan
6	74	0.24	England
7	61	0.02	Taiwan (Peoples R China)
8	59	0.1	Spain
9	56	0.2	Germany
10	56	0.01	South Korea
11	51	0.37	Italy
12	50	0.05	Poland
13	46	0.02	New Zealand
14	37	0.09	Sweden
15	34	0.01	Australia
16	30	0.02	Netherlands
17	27	0.01	Canada
18	25	0.01	Denmark
19	24	0.06	France
20	23	0.01	Pakistan

In order to analyze the distribution of published journals and cited journals about AP more specifically, we carried out the double-map overlaying atlas of journal types by visual analysis method (Fig. 3B).[10,11] Various geographic areas represent different categories of journal. The publication map can assist in better understanding diseases research dynamics. There were 4 main citation paths in the current map. The map on the left represented the citing journal. The map on the right represented the cited journal. In general, papers about AP were mainly published in medicine, medical, and clinical journals (All journal information can be found in Table 5), and the most cited papers were mainly published in health, nursing, medicine, and molecular, biology and genetics (all journal information can be found in Table 6). AP is a disease that requires multidisciplinary diagnosis and treatment. An increasing number of publication maps indicate that AP is closely related to the subject. Rare publication maps show that to date AP is not deeply integrated within this field due to limited technology, expertise, and knowledge. There remain interdisciplinary areas yet to be explored.

Table 5

Top 10 journals in terms of number of articles about AP published.

No.	Frequency (%) N = 2407	IF (2019)	Journal
1	128 (6.253%)	2.675	Pancreas
2	111 (5.423%)	3.241	Pancreatology
3	40 (1.954%)	1.870	Medicine
4	40 (1.954)	3.411	World Journal of Gastroenterology
5	38 (1.856%)	–	Journal of the Pancreas
6	31 (1.514%)	0.181	International Journal of Clinical and Experimental Medicine
7	31 (1.514%)	2.776	PLoS One
8	26 (1.270%)	4.011	Scientific Reports
9	25 (1.221%)	2.937	Digestive Diseases and Sciences
10	20 (0.977%)	1.448	Experimental and Therapeutic Medicine

IF = impact factor

3.4. Map analysis of co-cited literature

Co-citation in the scientific literature can to some extent reflect crucial literature in the field. Figure 4 is an analysis map of the co-cited literature on AP from 2015 to 2019, in which there were 161 nodes and 251 connections, and the density of topological network was 0.0195. To some extent, it showed the cooperative relationship between authors in this field. From the frequency table of co-cited literature (Table 7.), it can be found that among the co-cited documents with high frequency and centrality, 21 articles such as Banks PA (2013) are the core documents in this field, which are worthy of scholars to study.

3.5. Fund atlas analysis

Fund analysis map is a newly developed function of Citespace software, which can well observe the main sponsor funds of AP research. Figure 5 is the fund analysis map included in the literature, in which there were 85 nodes and 61 connections, and the density of topology network was 0.0048. Table 8 shows that among the top 5 funds, 1 was from mainland China, 2 from Taiwan (Peoples R China), 1 from the United States, and 1 from New Zealand. From Figure 5 we can also see that there are many scientific research fund projects involved in this research area, but the main funding directions come from natural sciences, medicine, pharmacy, etc.

3.6. Disciplinary attribute map analysis

Literature analysis based on subject attributes can help us sort out the subject attribute of a research field and promote comprehensive treatment of the disease. Figure 6 is a graph of discipline map analysis of the included literature. There were 53 nodes in total and 88 were connected. The topology density of the literature was 0.0639. From Table 9, we can know that the major subjects involved in the study of AP include: gastroenterology, internal medicine, surgery, nutrition, radiology, immunology, pediatrics, pharmacology, molecular biology, oncology, pathology, etc. In addition to some basic disciplines, it included many clinical departments, and different departments have their own strength in the treatment of AP, which fully illustrates the importance of exploring the attributes of AP. Generally speaking, in the clinical treatment and mechanism research of AP, how to give full play to the advantage of multi-discipline is still the direction of further exploration.

3.7. Keyword Co-occurrence visual atlas analysis

Keywords can represent the core point of an article, which is a summary and refinement of the main content of the research. In the keyword co-occurrence visualization graph based on Citespace software (Fig. 7A), there were 80 nodes, 207 research chains, and the density of the network topology was 0.0655. The number of research chains was larger than the number of nodes, which fully reflected the tightness of the relationship between keywords in this field, indicating that the focus of attention in this field is relatively concentrated in recent years. The denser network density as well indicates that scholars' research in this field has formed a systematic scale. Based on the keyword co-occurrence method, the clinical research mainly involved the "classification," "mortality", and "risk factors" of AP, and the experimental research mainly involved cell experiments, including the "expression" of genes and "activate." However, the effective information obtained based on Citespace software
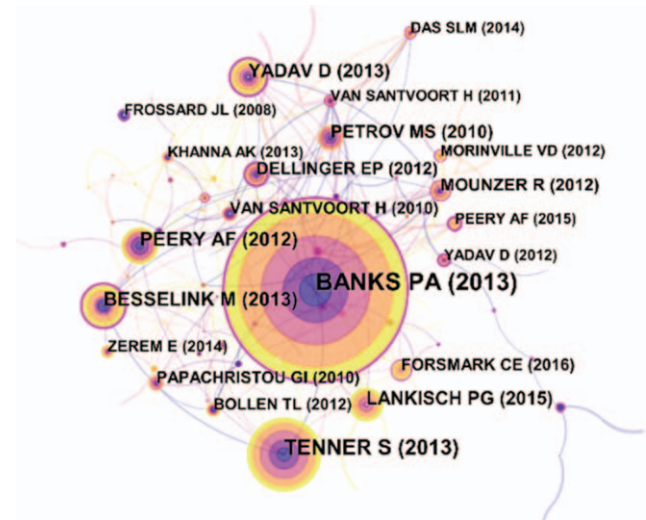
Figure 3. Journal atlas of published articles on AP. (A, Co-cited journal map on AP; B, Double-map overlaying atlas of journals publishing work related to AP). AP = acute pancreatitis.

(Fig. 7A) was relatively small and broad, which is of little significance for in-depth analysis and extended research.

Hence, we built a heat map of keywords again based on VOSviewer software (Fig. 7B). In this map, keywords were divided into core keywords, sub-core keywords, and edge keywords in the way of cold and warm tones. From Figure 7B, we can find that the core keywords were the same as the co-occurrence keywords built by Citespace software, but the outer circle was the sub-core keywords, such as cancer, surgery, interleukin-6, etc, and the edge keywords were at the junction of cold and warm tones, such as heme oxygenase-1, nrf-2, prss1, NF-kB and so on. Marginal keywords may be either cutting-edge words whose potential has not been discovered, or the intersection of research disciplines. Therefore, compared with Citespace's keyword co-occurrence map, this map can be analyzed in depth from 2 perspectives, that is, hot words and cutting-edge words.

3.8. Visual map analysis of keyword clustering

Keyword clustering visual graph analysis is a research method of clustering similar semantic keywords by Citespace according to a

specific algorithm.[12] It enriches the keyword co-occurrence method. Figure 8A is a keyword clustering map made by the software Citespace. In this present study, a total of 5 clusters were formed, mainly including: SAP, elevated serum triglyceride, protective effect, population-based case-control study, and chengqi decoction. Similarly, the keyword clustering map based on Citespace is relatively limited, so we performed keyword clustering analysis through 2 other methods, which are presented in Figure 8B and C.

Figure 8B is a keyword clustering map based on Citespace using Vosviewer software. From Figure 8B, it can be found that keywords were mainly divided into 4 clusters according to different colors: Cluster 1 (red) had 210 keywords-basic researches mainly based on inflammation. Cluster 2 (cyan) had 137 keywords, clinical risk factors for AP. Cluster 3 (blue) had 102 keywords which were mainly about the diagnosis and management of AP. Cluster 4 (light yellow) had 74 keywords, which was mainly classified based on AP and its severity and mortality. Compared to the keyword clustering made by Citespace, Vosviewer's clustering map can show more clusters and broader content, covering most studies of AP. Figure 8C is a

Table 6

Top 20 journals in terms of times of co-citation.

No.	Frequency	Centrality	Journal
1	1217	0.25	Pancreas
2	1152	0.23	Gut
3	1071	0.26	Gastroenterology
4	985	0.02	Pancreatology
5	962	0.01	World J Gastroentero
6	958	0.25	Am J Gastroenterol
7	612	0.02	Ann Surg
8	603	0.01	Brit J Surg
9	514	0.01	New Engl J Med
10	490	0.01	Lancet
11	446	0.01	Plos One
12	443	0.01	Digest Dis Sci
13	415	0.01	Clin Gastroenterol H
14	408	0.01	J Clin Gastroenterol
15	387	0.12	Crit Care Med
16	341	0.01	J Pancreas
17	337	0.06	Arch Surg-Chicago
18	334	0.01	Scand J Gastroentero
19	325	0.01	Surgery
20	291	0.04	J Gastroen Hepatol

Figure 4. Co-cited literature map on acute pancreatitis.

map based on the combination of Citespce and external Carrot software. The WOS database literature is displayed in the form of visualization through Carrot to form a visual map of the bubble tree. Figure 8C divides the entire literature into 83 clusters. The author selected 11 clusters with the cluster score greater than 10 and ranking in the top 20 frequencies: Levels in AP (cluster 0), Case Report (cluster 3), Score is Useful (cluster 4), Methods for Predicting (cluster 5), Clinical Cases (cluster 8), Treatment of Patients with SAP (cluster 9), Levels Measured (cluster 10), Case of AP Associated (cluster 13), Complicated Cases (cluster 16), Model Group (cluster 17), Hospital Mortality (cluster 19). Although the results obtained by this method were different from the former 2 results, their basic contents and structures were similar, which also proved the reliability of our method and results.

4. Discussion

In this study, the literature on AP in the WoSCC database from 2015 to 2019 was bibliometrically analyzed by using Citespace V, Vosviewer, and Carrot, and the distribution characteristics of authors, institutions, funds, and disciplines in the literature were deeply excavated. After keyword co-occurrence and cluster analysis, the attention direction and research trends of AP in the past 5 years were discussed. The knowledge graph of related research on AP was analyzed comprehensively from multiple angles. The researches of Huang et al. and Zhao et al are similar to our research in terms of the software and research ideas, and the difference is that the research does not involve the clustering analysis of keywords by Carrot.[13,14] Of course, there are other bibliometric studies using this software for analysis, such as the study by Lu et al, but it is completely different from our research direction.[15]

Table 7

Top 20 articles cocited.

No.	Frequency	Centrality	Article
1	641	0.35	Banks PA, 2013, Gut, V62, P102, DOI 10.1136/GUTJNL-2012-302779
2	271	0.04	Tenner S, 2013, Am J Gastroenterol, V108, P1400, DOI 10.1038/AJG.2013.218
3	153	0.24	Besselink M, 2013, Pancreatology, V13, P0, DOI 10.1016/J.PAN.2013.07.063
4	135	0.01	Peery AF, 2012, Gastroenterology, V143, P1179, DOI 10.1053/J.GASTRO.2012.08.002
5	133	0.23	Yadav D, 2013, Gastroenterology, V144, P1252, DOI 10.1053/J.GASTRO.2013.01.068
6	126	0.06	Lankisch PG, 2015, Lancet, V386, P85, DOI 10.1016/S0140-6736(14)60649-8
7	99	0.03	Petrov MS, 2010, Gastroenterology, V139, P813, DOI 10.1053/J.GASTRO.2010.06.010
8	87	0.21	Dellinger EP, 2012, Ann Surg, V256, P875, DOI 10.1097/SLA.0B013E318256F778
9	77	0.12	Mounzer R, 2012, Gastroenterology, V142, P1476, DOI 10.1053/J.GASTRO.2012.03.005
10	68	0.11	Forsmark CE, 2016, New Engl J Med, V375, P1972, DOI 10.1056/NEJMRA1505202
11	68	0.08	Papachristou GI, 2010, Am J Gastroenterol, V105, P435, DOI 10.1038/AJG.2009.622
12	63	0.06	Van Santvoort H, 2010, New Engl J Med, V362, P1491, DOI 10.1056/NEJMOA0908821
13	60	0.08	Bollen TL, 2012, Am J Gastroenterol, V107, P612, DOI 10.1038/AJG.2011.438
14	53	0.01	Zerem E, 2014, World J Gastroentero, V20, P13879, DOI 10.3748/WJG.V20.I38.13879
15	49	0.01	Frossard JL, 2008, Lancet, V371, P143, DOI 10.1016/S0140-6736(08)60107-5
16	47	0.03	Khanna AK, 2013, Hpb Surg, V2013, P367581, DOI 10.1155/2013/367581
17	47	0.11	Morinville VD, 2012, J Pediatr Gastr Nutr, V55, P261, DOI 10.1097/MPG.0B013E31824F1516
18	46	0.17	Das SLM, 2014, Gut, V63, P818, DOI 10.1136/GUTJNL-2013-305062
19	43	0.27	Peery AF, 2015, Gastroenterology, V149, P1731, DOI 10.1053/J.GASTRO.2015.08.045
20	42	0.15	Van Santvoort H, 2011, Gastroenterology, V141, P1254, DOI 10.1053/J.GASTRO.2011.06.073

Figure 5. Map analysis of funding fund for acute pancreatitis.

The published author is a crucial observation index of literature review. Using CiteSpace software, we can sort out the core authors and then find the main research teams in the research field in the field, such as Li WQ team and Petrov MS team. The significance of this result is that in the process of studying AP, if academic exchanges between some topics or some issues need to be discussed, scholars can consult relevant experts on the basis of Delphi expert survey method.[16] Based on this method, we found that Li WQ team, relying on its clinical resources, mainly engaged in clinical and basic research of AP and focused on the posttreatment of SAP.[17,18] In addition, the team created the world's first professional AP data website for global learning and exchange in 2018, which contribute to the understanding and exchange of AP.[19]

The author co-citation analysis is based on the references of the included literature, and results are obtained by reading the core author's literature. The results can better grasp the core content of the field and facilitate the grasp of the current status and development trends of AP.[20] Therefore, the author believed that the author's co-citation analysis places more emphasis on the quality of citations than the author of the article. In the author co-citation analysis, 4 core authors appeared simultaneously: Petrov MS, Papachristou GI, Yadav D, and Whitcomb DC. This indicated that the 4 scholars were authoritative experts in the field, and had carried out a lot of practice and exploration in the field, and their research had a high reference value.

Visual analysis of research institutions and countries helps us to understand the research landscape in this area. From the research institutions map (Fig. 2A) and Tables 3 and 4, we found that most of the publishing institutions are worldwide famous universities. Of these school institutions, 6 are comprehensive

colleges and 4 are specialized medical universities or research centers. Moreover, among the top 10 institutions, 7 are from China and the other 3 are from the United States. It can be seen that most of the studies on AP come from the 2 largest economies in the world. It also shows that the research on AP needs a lot of funds and talents. Our judgment is further proved in combination with the published country map (Fig. 2B). At the same time, from Tables 3 and 4, it can be seen that with the exception of China, India, and Pakistan, most of the research countries in this field are developed countries, indicating that the research in this field in developing countries started relatively late. Based on a comprehensive analysis of the issuing organizations and countries, the most authoritative and core countries and institutions are concentrated in China and the United States. Though China started a little later than the United States, it has already ranked top in the world in this field of research by virtue of its strong investment in capital and talents.

In addition, through the inter-agency cooperation map (Fig. 2A), we also found that inter-agency and inter-national cooperation had become a norm. Among the many cooperative relationships, it is worth noting that Shanghai Jiao Tong University has established cooperative relationships with Tongji University and Soochow University that mainly engaged in the pathogenesis of AP.[21,22] The collaborative study between Sichuan University and Liverpool University focused not only on the pathogenesis of AP, but also on chronic pancreatitis.[23,24] These examples of cooperation illustrate the important role of inter-agency cooperation in the study of AP and are worth learning by other research institutions.

In the past 5 years, a total of 693 journals have published studies on AP, of which 91 journals have published more than 5 articles on AP. Among the top 10 journals in terms of the number

Table 8			
Top 5 of funds.			
No.	Frequency	Centrality	Fund
1	217	0.45	National Natural Science Foundation of China
2	27	0.11	NIH (USA National Institutes of health)
3	24	0.01	Taiwan Ministry of Health and Welfare Clinical Trial and Research Center of Excellence
4	15	0.01	WORLD JOURNAL OF Health Research Council of New Zealand
5	12	0.01	NRPB Stroke Clinical Trial Consortium

Figure 6. Discipline map analysis of acute pancreatitis.

No.	Frequency	Centrality	Subject
1	684	0.18	Gastroenterology and hepatology
2	303	0.07	General and internal medicine
3	266	0.17	Medicine, general and internal
4	198	0.46	Research and experimental medicine
5	198	0.01	Medicine, research, and experimental
6	153	0.14	surgery
7	139	0.57	Pharmacology and pharmacy
8	90	0.12	Biochemistry and molecular biology
9	74	0.1	Cell biology
10	67	0.13	Oncology
11	65	0.07	Science and technology – other topics
12	62	0.01	Multidisciplinary sciences
13	60	0.12	Pediatrics
14	57	0.06	Immunology
15	56	0.12	Radiology, nuclear medicine, and medical imaging
16	47	0.13	Nutrition and dietetics
17	45	0.06	Endocrinology and metabolism
18	43	0.01	Emergency medicine
19	37	0.08	Pathology
20	37	0.13	Physiology

of publications (Table 5), the number of articles published accounts for 24% of the total, or about 1/5. These journals have a total influence factor ranging 3 to 5, with an average influence factor of 2.5 (2019). The *Pancreas* (IF 2019, 2.9; 128 articles, 6.253%) published the most articles related to AP, followed by *Pancreatology* (IF 2019, 3.0, 111 articles, 5.423%). The number of related papers published in 5 years has exceeded 100. Among co-cited journals, *Pancreas* is also ranked first, followed by *Gut, Gastroenterology, Pancreatology,* and *World J Gastroentero.* The significance of the analysis of published journals lies in the fact that the position of the discipline in the entire medicine can be analyzed from the perspective of citation.

In the fund analysis map (Fig. 5), although there are many fund projects involved, most of them are funded projects applied by scholars or scientific research institutions, even if the cooperation and exchange between articles do not involve the superposition of funds. This fact shows that scholars in this field are more rigorous in their research and will not deliberately accumulate funds to improve the hit rate of articles. Further, the fund analysis can help researchers working on AP to figure out where they can get more funds.
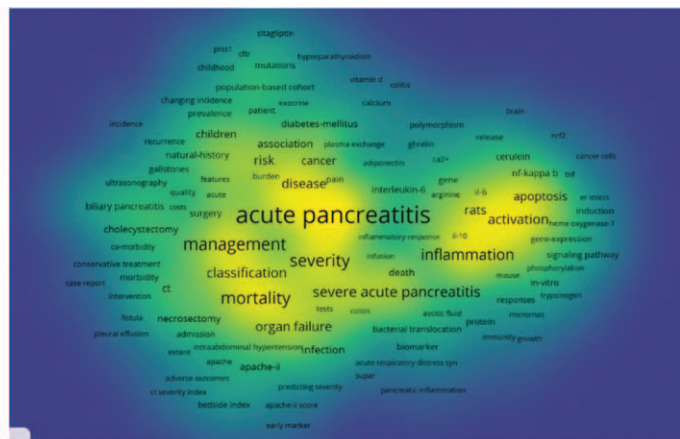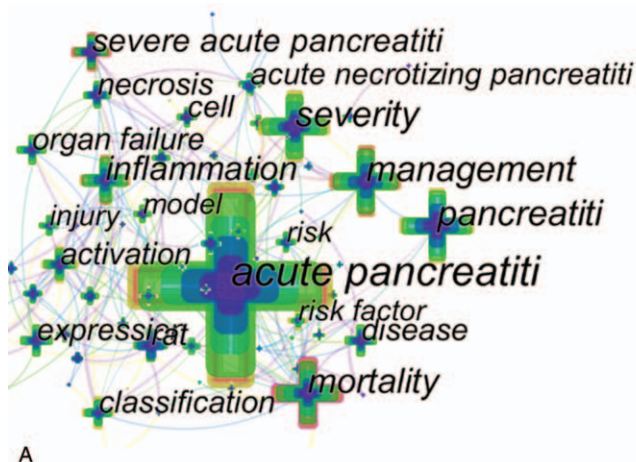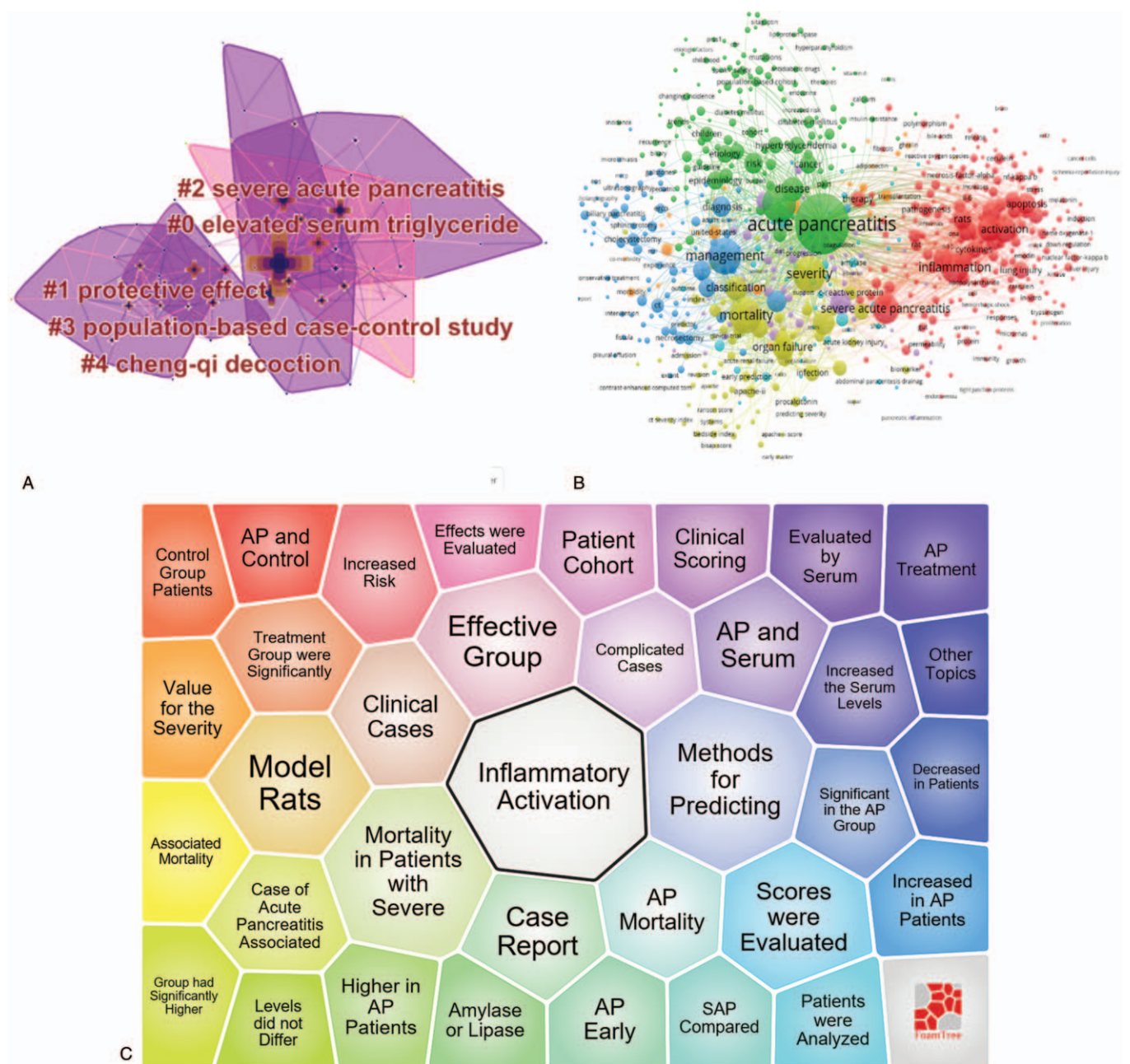

Figure 7. Visual map of keyword co-occurrence on AP. (A, Co-occurrence map of keywords based on CiteSpace; B, Frequent keyword-time dual-map for AP based on Vosviewer). AP = acute pancreatitis.

Figure 8. Visual map of keyword clustering on AP. (A, Clustering map of keywords based on CiteSpace; B, Density map of AP frequent keywords based on Vosviewer; C, Major topic survey for the AP based on the Carrot software). AP = acute pancreatitis.

Advanced AP will cause injury to multiple organs throughout the body, so an increasing number of scholars have realized that it is not only a problem of the pancreas. To treat the AP and reduce its mortality, we need to rely on the intersection of multi-disciplines, from basic to clinical, from internal medicine to surgery, from physiology to pathology, etc.[25] The latest authoritative literature demonstrated that AP is not a self-limiting disease, which makes the collaborative diagnosis and treatment among various departments a trend.[1] At present, many experts have begun to call for multidisciplinary research on treatment.[26] The subject attribute analysis map (Fig. 6) fully illustrates the value of multidisciplinary diagnosis and treatment mode (MDT) in AP. Among the disciplines involved, the two disciplines of medical experiment and

pharmacology are not particularly high in frequency, but the degree of centrality is much more prominent than other disciplines, so it is speculated that the research of these two disciplines on AP remain to be explored in-depth.

Co-cited references usually have good summarization or expansibility, which can help readers find the most valuable documents, and their research can guide the basic direction or hot issues in this field. In order to highlight the core references, we made a cross-comparison between the co-cited core authors and the authors in the co-cited core documents, and found that the authors of 7 articles appeared among the co-cited core authors (red part in Table 7). Therefore, these 7 articles are the most important and valuable ones in this field, and they are worth

learning. Among these 7 articles, there is 1 clinical retrospective study of AP (published in 2012),[27] 1 article on classification criteria of AP (published in 2013),[28] 2 articles on guidelines for AP (both published in 2013),[29,30] 1 epidemiological survey (published in 2014),[31] and 2 reviews (published in 2015 and 2016, respectively).[32,33] These 7 articles have a clear context, which indicates to some extent the development of clinical treatment for AP in recent years.

The co-occurrence of keywords mainly involves the classification, mortality, and risk factors of AP, which is consistent with the clinical concerns. Moreover, the judgment of mortality and risk factors of AP is closely related to its classification, and the latest literature supports this conclusion.[34,35] Of course, the expression and activation of some well-known factors or genes, such as nrf-2 and prss1, is still of the major focus of mechanism research. Our results based on keyword co-occurrence include, but are not limited to, the latest authoritative literature.[36] Based on the results of cluster analysis of keywords, the research pattern of AP in the past 5 years and the possible research trend in the future are further explored. According to the results of different clustering methods, we comprehensively analyzed the co-cited clusters, including diagnosis and management of AP, population-based case-control studies, classification of AP, risk factors (elevated serum triglycerides), protective effects (Chengqi Decoction), etc. These are the current hot issues about AP, which have helped us to further understand the disease. It should be noted here that the traditional Chinese medicine represented by Chengqi Decoction should be combined with modern medical research methods in the treatment of AP in order to achieve its effectiveness.[37]

Based on the results of cluster analysis of keywords by Citespace, VOSviewer, and Carrot, we can find the research hotspots of AP in the past 5 years. The keyword clustering map based on Citespace has clear clustering tags and names, but it is easy to be changed by different clustering methods, and the number is difficult to be controlled. The keyword clustering graph based on Vosviewer software can reflect more clustering words, which is suitable for big data clustering. However, the nodes in the software graph are automatically generated and cannot be changed. Synonyms easily appear in the cluster, causing ambiguity, and there is no obvious boundary between nodes, so it is difficult to identify small clusters.[38,39] Based on the Carrot software, there are a large number of keywords clusterers. The foam tree clustering map can strictly separate each cluster, and we can choose large clustering or small clustering according to the needs. No matter how many clusters there are, the map is clear, which is the best choice among the 3 sets, but its disadvantage is that the original data need to be copied in advance before use, and the operation is complicated.[40]

5. Conclusions

Based on Citespace, VOSviewer, and Carrot software, this paper analyzed bibliometrics of AP literature included in WoSCC in the past 5 years and made an in-depth interpretation of the included literature from the aspects of the co-occurrence of research authors, institutions, funds, subject attributes, and keywords, and cluster map analysis. We not only understood the current research status of AP as a whole, but also found the research hotspots and trends in this field, and presented them in the form of a map. It can help us extract useful information from complex data and provide more ideas for clinicians and researchers.

Finally, we hope that there will be a greater clinical breakthrough in AP!

Author contributions

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Software: Wenjie Sun.
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Writing – original draft: Wenjie Sun.
Writing – review & editing: Dianxu Feng.

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