Methods and Applications

Bibliometric Analysis on Utilization of New Information Technology in the Prevention and Control of COVID-19 — China, 2020

Dan Li[1]; Songwang Wang[1,#]; Xuemei Su[1,#]

ABSTRACT

Introduction: New information technology (IT) has been applied to prevent and control coronavirus disease 2019 (COVID-19) in many regions of China since the outbreak of COVID-19. This study aims to illustrate the current status and key areas of the application of new IT in the prevention and control of COVID-19.

Methods: Literature related to the prevention and control of COVID-19 with new IT since 2020 was retrieved from China National Knowledge Internet and Wanfang Literature databases, the two most authoritative databases in China. CiteSpace 5.7.R2 was used to analyze the institutions, authors, and keywords of the articles. The application of new IT is determined by keywords and highly cited documents.

Results: A total of 1,711 articles were included, as the number of publications has been continually increasing over the investigation period. The six hot topics of new IT applied in COVID-19 were big data, artificial intelligence, Internet+, blockchain, Internet of Things, and 5G. The most productive institution is University of Chinese Academy of Sciences, and the most productive author in this field is Tao Pei, whose article, "Multi-level Spatial Distribution Estimation Model of the Inter-Regional Migrant Population Using Multi-Source Spatio-Temporal Big Data: A Case Study of Migrants from Wuhan During the Spread of COVID-19," was highly cited.

Discussion: This study could help medical professionals understand the application status and research trends of new IT in the prevention and control of COVID-19. This paper also helps researchers find potential co-operative institutions and partners.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) has caused more than 70 million reported cases and more than 1 million deaths worldwide since emerging at the end of 2019, causing huge human capital loss and material and financial losses in 2020. A series of traditional infectious disease prevention and control measures, including wearing masks, going out less frequently, washing hands, and social distancing were taken to control COVID-19 (*1*).

Unlike past infectious diseases, COVID-19 is currently the only large-scale epidemic that humankind has encountered in the era of big data. More importantly, many new information technologies (ITs) have been used to help to control the epidemic. According to experts, the new generation of information technology, includes big data, artificial intelligence (AI), 5G, Internet of Things (IOT), blockchain, and other technologies (*2*). In this article, new IT is confined to AI, big data, blockchain, 5G, internet, cloud computing, IOT, robotics, bluetooth, and knowledge graphs. This study explores and summarizes the new IT's current role in responding to COVID-19.

METHODS

Data Acquisition

The literature data used in this study were retrieved and downloaded from the China National Knowledge Internet (CNKI) and Wanfang Literature databases. The publication date was defined as "after 2020", and the literature type was defined as "article." By searching [topic: (AI or big data or blockchain or 5G or internet or cloud computing or IOT or robotics or Bluetooth or data modeling or internet public opinion or Search Engine or knowledge graphs) and topic: (COVID-19 or NCP*)] and Date: 2020-* (searching date: December 24, 2020) as well as removing duplicate and off-topic literature and excluding review and report

* NCP: novel coronavirus pneumonia.

papers, a total of 4,621 articles were retrieved, of which 1,711 references were included in this study. At the same time, all papers were screened by experts, and controversial documents were further discussed to decide their eligibility.

Analysis Tool

This study used Citespace5.7.R2 software for bibliometric analysis, as it highlighted the keywords, authors, institutions, and other information of the literature and generated visual knowledge maps composed of nodes and links. Each node in a map represents an element, such as institution, author, and keyword, and the size of the node is proportional to the frequency with which the selected node type occurs. The number of connections and the strength of links between nodes represented relationships of collaboration or co-citations between nodes, and the number is in direct proportion to the degree of connection. The centrality of a node referred to the number of any shortest paths through this point in its network and was a measure of the connecting role played by a node in the overall network. Nodes with centrality ≥0.1 were called critical nodes. Network density represented the density of the network generating knowledge graph. The different colors of nodes and lines represented different publication years (*3*).

The parameters of CiteSpace were defined as follows: time slicing (2020–2021), years per slice (*1*), term source (all selection), node type (choose one at a time), selection criteria (top 50%), and pruning (pathfinder).

RESULTS

Analysis of the Institutions

Taking "institution" as the node type, the map produced 316 nodes and 181 links. In total, 1,711 articles came from 316 institutions. The top five institutions that produced the most articles were: University of Chinese Academy of Sciences; School of Architecture, Tsinghua University; Institute of Geographic Sciences and Natural Resources Research, University of Chinese Academy of Sciences; China Academy of Information and Communications Technology; School of Information Management, Wuhan University. There were some collaborations between these institutions. However, the centrality of the collaborations was 0, indicating that the collaboration among research institutions was insignificant.

Analysis of the Authors

Taking "author" as the node type, the map produced 212 nodes and 386 links. The 1,711 articles were written by 212 authors. Removing the influence of the same name, the top five authors are Tao Pei, Ci Song, Xiaoxiang Zhang, Ying Long, and Chenghu Zhou.

These authors are regarded as active researchers in the area. References with high citation frequency by active authors can be regarded as hot topics in the research field. The most highly cited article among his publications on COVID-19 prevention and control is "Multi-level Spatial Distribution Estimation Model of the Inter-Regional Migrant Population Using Multi-Source Spatio-Temporal Big Data: A Case Study of Migrants from Wuhan During the Spread of COVID-19," published in the *Journal of Geo-Information Science*, focusing on the estimation of the spatial distribution of the displaced population in Wuhan based on big data (*4*). This paper showed that big data can quickly respond to public health emergencies and provide scientific numeric support for decision-making. There were some collaborations among authors, but the centrality of the collaborations was 0, indicating insignificant collaboration among authors.

Analysis of Keyword Cooccurrence

Taking "term" and "keyword" as the network nodes, after combining synonyms and deleting of meaningless keywords, the generated keyword knowledge map contains 179 nodes, 299 links, and a network density of 0.0188 (Figure 1). The top 20 keywords and their frequency centrality are shown in Table 1.

The frequency of keywords showed that the application of new IT in the prevention and control of COVID-19 mainly focused on big data, artificial intelligence, internet, blockchain, IOT, and 5G. It was mainly used in public opinion monitoring, online teaching, telemedical system, emergency management, outbreak prediction, and epidemic information visualization. The details of six hot topics about new IT were as follow:

1) Big data

As shown in Figure 1 and Table 1, the most often used new IT was big data. Big data were applied in the

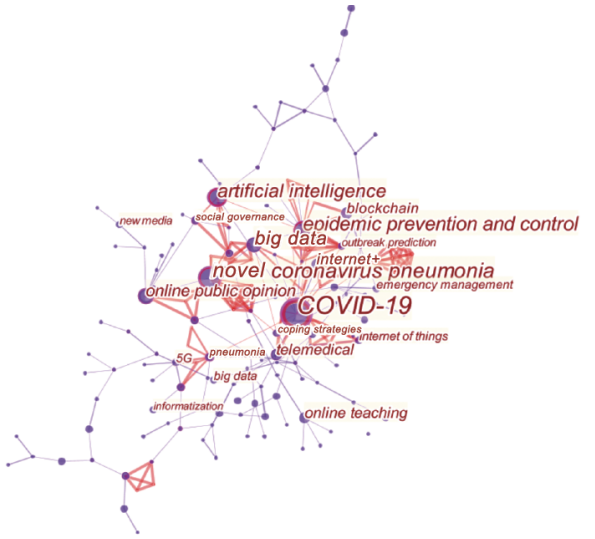

FIGURE 1. Co-occurrence of 179 keywords related to the application of new information technologies to the COVID-19. Each dot in the graph represents a keyword, and the lines indicate the relationship between the keywords. It was evident that the new information technologies in the prevention and control of the COVID-19 epidemic were large and interconnected.

analysis of online public opinion, population movement, close contacts investigation, timely acquisition of epidemic information, and the estimation of the spread of information (*5*).

2) AI

AI combined with computed tomography (CT) were used to assist doctors in diagnostics. AI was also combined with big data to improve the epidemic prediction model, as well as being combined with robotics to perform ward management (*6*).

3) Internet Plus (Internet+)

Thanks to Internet+, telemedical and online teaching were also in the top 20 co-occurring keywords. In order to reduce the flow of people and decrease in-person transits, educational institutions adopted online teaching through the slogan of "No In-Person Teaching, No Suspension of Studying". Most colleges and universities relied on the internet to carry out online teaching in the form of live or recorded broadcasting (*7*). In the medical field, many public hospitals opened internet diagnosis and treatment services, such as fever clinics and COVID-19 symptoms consultations, to re-allocate medical resources, optimizing the usage of medical resources (*8*).

4) Blockchain

Blockchain was mainly used for emergency material

TABLE 1. The top 20 keywords about the application of new information technology to prevention and control of COVID-19, December 24, 2020.

Number	Frequency	Centrality	Key words
1	613	0.76	Coronavirus Disease 2019 (COVID-19)
2	239	0.43	Novel coronavirus pneumonia
3	148	0.35	Epidemic prevention and control
4	119	0.31	Big data
5	107	0.46	Artificial intelligence
6	54	0.01	Internet+
7	49	0.27	Online public opinion
8	45	0.06	Online teaching
9	38	0.12	Telemedical
10	26	0.08	Blockchain
11	18	0.02	Internet of things
12	18	0.04	5G
13	17	0.06	Emergency management
14	17	0.02	Outbreak prediction
15	14	0.02	New media
16	13	0.10	Social governance
17	12	0.43	Coping strategies
18	12	0	Informatization
19	12	0.29	Pneumonia
20	12	0.06	Epidemic information visualization

supply management in COVID-19 prevention and control. Blockchain could provide anti-counterfeiting and traceable services for rescue materials. The materials embedded with blockchain technology assisted in keeping accurate transportation records, which effectively promoted information exchange and resource coordination during the process of material allocation. Blockchain could also be coordinated with technologies like artificial intelligence, health codes, IOT, and private chains to investigate close contacts (*9*).

5) IOT

The IOT was combined with artificial intelligence and blockchain for auxiliary diagnosis and treatment, the delivery of rescue materials, and management of community residents (*10*).

6) 5G

In the COVID-19 epidemic, 5G provided network infrastructure for square-cabin (Fangcang Shelter) hospitals, Huoshenshan Hospital, and Leishenshan Hospital. It also provided network support for the hospitals' telemedicine and robots, and other information facilities (*11*).

DISCUSSION

Based on the bibliometric analysis of new IT in the Prevention and Control of COVID-19 publications in China 2020, the amount of relevant literature has been bountiful. The phenomenon of cooperation among multiple authors is widespread in this research field. Almost all highly cited articles were completed by more than one author. However, cooperation among institutions was not as wide.

This research suggested that many new information technologies played important roles in various aspects of COVID-19 prevention and control. They were used either with other new ITs or with traditional industries.

Big data was used most widely in the process of COVID-19 prevention and control among all new information technologies. It was especially common in the investigation of close contacts, during which it largely supplements traditional epidemiological investigations. The combination of artificial intelligence technology and lung CT examination technology enabled doctors to make diagnoses much faster. In addition, 5G technology was quickly built in square-cabin (Fangcang shelter) hospitals, Huoshenshan Hospital, and Leishenshan Hospital due to its high broadband, low latency, and wide connection advantages. The information system and wireless network were fully covered to help Wuhan Hospital's COVID-19 prevention and control. The Internet of Things and blockchain were combined with big data and artificial intelligence technology to construct personal health codes and deliver of rescue materials.

At the same time, under the circumstance that many local cases caused by frozen imported products, it is recommended that we establish a blockchain-enabled tracing system for imported frozen products based on the safety and traceability characteristics of blockchain. Accordingly, virus tracing and COVID-19 control can be carried out as soon as possible after local cases occur. In terms of medical care, many hospitals relied on internet technology to open online consultation services, and patients could go to fever clinics online for consultation about COVID-19 symptoms. In terms of education, from elementary schools to universities, educational institutions could continue online teaching in the form of live broadcast or recording.

This study was subject to some limitations. First, the literature data of this study came from CNKI and Wanfang Literature databases, so domestic experts' papers published in foreign journals were not included in this study. Second, this study only focused on literature with high citation frequency at the present stage, and a bias may exist in the results of study analysis and the actual status of the studies because more recent papers will have fewer times cited. Finally, all papers were retrieved on November 30, 2020, and the literature after that was not included.

In conclusion, this study could help medical professionals understand the application status and trends of new IT in the prevention and control of COVID-19 and help researchers find cooperative institutions and partners.

Funding: Application of big data processing and analysis for pathogen monitoring of infectious disease syndromes based on cloud computing technology and construction of sharing platform (No. 2018ZX10713001-012).

doi: 10.46234/ccdcw2021.047

[#] Corresponding authors: Songwang Wang, wangsw@chinacdc.cn; Xuemei Su, suxm@chinacdc.cn.

[1] Information Center, Chinese Center for Disease Control and Prevention, Beijing, China.

Submitted: January 25, 2021; Accepted: January 29, 2021

REFERENCES

1. National Health Commission. Prevention and control plan of COVID-19 (7th edition). Chin J Infect Control 2020;19(11):1042 – 8. http://dx.doi.org/10.12138/j.issn.1671-9638.20206164. (In Chinese).
2. The State Council of the People's Republic of China. "The decision on speeding up the cultivation and development of strategic emerging industries" was issued by the State Council. http://www.scio.gov.cn/xwfbh/xwbfbh/wqfbh/2012/0608/xgzc/Document/961711/961711.htm. [2010-10-27]. (In Chinese).
3. Chen CM. Science mapping: a systematic review of the literature. J Data Inf Sci 2017;2(2):1 – 40. http://dx.doi.org/10.1515/jdis-2017-0006.
4. Liu Z, Qian JL, Du YY, Wang N, Yi JW, Sun YR, et al. Multi-level spatial distribution estimation model of the inter-regional migrant population using multi-source spatio-temporal big data: a case study of migrants from Wuhan during the spread of COVID-19. J Geo-Inf Sci 2020;22(2):147 – 60. http://dx.doi.org/10.12082/dqxxkx.2020.200045. (In Chinese).
5. Zhao XM, Li XH, Nie CH. Backtracking transmission of COVID-19 in China based on big data source, and effect of strict pandemic control policy. Bull Chin Acad Sci 2020;35(3):248 – 55. http://dx.doi.org/10.16418/j.issn.1000-3045.20200210002. (In Chinese).
6. Lyu ZB, Guan CS, Yan S, Chen QY, Li JJ, Zhang YJ, et al. Value of CT findings in predicting transformation of clinical types of COVID-19. J Cap Med Univ 2020;41(3):340 – 4. http://dx.doi.org/10.3969/j.issn.1006-7795.2020.03.004. (In Chinese).
7. Feng W, Zhang LN, Li JY, Wei T, Peng TT, Zhang DX, et al. Analysis of special ehealth service for corona virus disease 2019 (COVID-19) pneumonia. J Peking Univ (Health Sci) 2020;52(2):302 – 7. http://dx.doi.org/10.19723/j.issn.1671-167X.2020.02.018. (In Chinese).
8. Wu DG. The retrospect and reflection of educational technology evolution: online teaching in universities under the epidemic situation. China High Educ Res 2020(4):1 – 6, 11. http://dx.doi.org/10.16298/j.cnki.1004-3667.2020.04.01. (In Chinese).
9. Hu QH, He J, Dong Q. Research on emergency materials supply information management of medical epidemic prevention under blockchain architecture——targeted donation of COVID-19 prevention materials as an example. Health Econ Res 2020;37(4): 10-4. https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbnameCJFDLAST2020&filenam=WSJJ202004004&v0dzPaFRyijo5ruSAuQAsCOF%25mmd2BJ9Hl57%25mmd2BrT8gBvmVjvnLVsUDYxJZ06zoTlclPgp7J. [2021-1-15] (In Chinese).
10. Bai L, Yang DW, Wang X, Tong L, Bai CX, Zhong NS. Chinese experts consensus on the Internet of Things-aided diagnosis and treatment of COVID-19. Fudan Univ J Med Sci 2020;47(2):151 – 60. http://dx.doi.org/10.3969/j.issn.1672-8467.2020.02.002. (In Chinese).
11. Zhou B, Wu Q, Zhao XF, Zhang WC, Wu WJ. Practice of cabin hospital network and information system based on 5G all wireless technology. China Digit Med 2020;15(5):5 – 7. http://dx.doi.org/10.3969/j.issn.1673-7571.2020.05.002. (In Chinese).