

The Latest Progress of Research on the Social Risks and Regulation of International Artificial Intelligent in Medical Treatment Based on CiteSpace Method

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Abstract—CiteSpace refers to a kind of citation visual analysis software developed on the basis of scientometrics and data virtualization. To explore the hot spot of social risk and regulation of international artificial intelligent (AI) in medical treatment, this paper retrieves the paper in 2000-2019 by taking the paper core set of Web of Science as the retrieval database and inputting keywords and then reflects the structure, rules and distribution of science and technology knowledge of the retrieved information, through visual means via CiteSpace. By analyzing data from such aspects as the number of publications and citations, ranking of publishing journals, clustering analysis of co-cited literatures and co-occurrence analysis of keywords, this paper brings the following discoveries: there are few research results related to “AI + social risk and regulation+medical”, EU’s leading status in the study of AI ethnics and law, and the scholars’ focus in recent years: 1. Some new issues of DNA sequencing technology in terms of laws and ethnics; 2. Personal information privacy at the medical data collection end and AI application end and medical privacy safety; 3. Decision-making of medical robot; 4. The standard application of AI in medical field; 5. Standardization of AI medical device; 6. Nanometer safety. Among all the issues above, the ethnic reorganization of doctor-patient relationship of AI-aided medical treatment triggers extensive concerns.

Keywords—medical artificial intelligence, social risk, risk governance, CiteSpace

I. INTRODUCTION

Artificial intelligence (AI) has been evolved and developed for more than 60 years since its appearance and AI technology has been used in medical field more extensively than ever, such as da Vinci operation aided robot, Watson doctor, AI virtual nursing assistance and automated working process manager, etc. However, there are also many problems happening to the application of AI technology in medical field, such as ethnic problems, individual information, data privacy, etc. Scholars also started to study the social risks and regulation of AI intelligent medical devices. The earliest periodical could be traced back to Social Implications of nanomedicine - Considering both the Risks and Benefits of Nanomedicine, which was written by the US scholar Jaeger, JF and was included in the periodical CHIMICA OGGI-CHEMISTRY TODAY.

CiteSpace is a kind of diversified, time-sharing and dynamic citation analysis software used for analyzing the potential knowledge contained in science literatures and developed on the background of scientific measurement, data and information virtualization. [1] This paper carries out visual analysis on the research of “social risks and regulation of AI in medical treatment” by using CiteSpace5.0 R4 SE so as to conclude research hot spot and the latest development trend and therefore prejudice the research trend.

II. DATA SOURCE, COLLECTION AND ANALYSIS METHOD

A. Data Source and Collection

This paper carried out search and retrieval by taking the core set database of Web of Science (WOS) as the data source. Retrieval formula: ((TS = ethical issues OR TS = moral standards OR TS =supervision path OR TS = medical devices OR TS = medical artificial intelligence OR TS = artificial intelligence robot) AND (TS=social risk OR TS=legal regulation)) AND language: (English) AND literature type: (Article) index =SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, CCR-EXPANDED, IC time span =2000-2019; retrieval date: December 1, 2019. A total of 789 literatures were retrieved. Manual search complying with the theme requirements was made within the scope. A total of 128 related academic papers were found (all of them are Article), which were cited for 1,674 times altogether.

B. Analysis Method

The full data record obtained through retrieval and the cited literatures were exported in the format of pure translation and then they were named in the format of download_***. Visual analysis was made against the author, organization, nation, periodical, co-cited literatures and keywords via using CiteSpace5.0 R4 SE software, relevant virtualization map was drawn and the research hot spot related to the social risks and regulation of AI technology in medical treatment and the latest development trend were analyzed comprehensively so as to prejudice the research trend.

III. RESULTS

A. Analysis on the Number of Publications and Citations

In 2000-2019, there were altogether 128 literatures

related to social risks and regulation of the application of AI intelligent technology in medical treatment but no relevant literatures were retrieved in 2000-2007. In 2008-2018, the

number of literatures varied within the range of 5-13 but the number rose in the following 2018 and 2019 continuously. (See Fig.1)

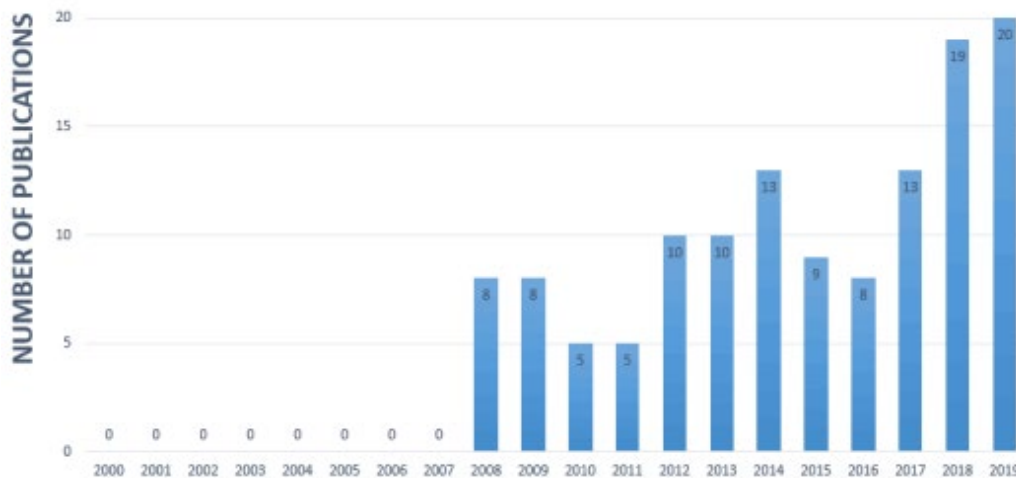


Fig.1. Number of publications on the research hot spot related to the social risks and regulation of AI in medical treatment in 2008-2019.

B. Ranking of Publications

The top 10 periodicals related to the social risks and regulation of the application of AI intelligent technology in medical treatment are shown in TABLE I. The number of publications by the top 10 periodicals accounts for 30% of the total number, which reveals that the influence factor of these literature periodicals was 2.9208 and 2.552 in 2018 and 2019 respectively. BMC MEDICAL ETHICS, which ranks the first in terms of number of publications, is actually a periodical that can be obtained in an open manner, which publishes the original peer review research articles with regard to biomedical research and clinical practice ethnics, including specialty choice and behavior, medical technology, medical health system and health policies. It was listed as

Ethics Zone 1 periodical by SCI of Chinese Academy of Sciences, with the average IF of 2.031 in the recent three years and 2,298 citation times in the recent two years. The IF was 2.77 in 2019. JOURNAL OF MEDICAL INTERNET RESEARCH ranking the second in terms of number of papers published number of publications is the first international peer review science periodical that studies every aspect of research, information and communication of medical health field comprehensively using Internet and intranet-related technologies. It was included as the periodical of hygiene and service zone 1 (Q1) by SCI of Chinese Academy of Sciences with the average IF of 4.930 in the recent three years and 24,477 citation times in the recent two years. The IF was 5.82 in 2019.

TABLE I. TOP 10 COUNTRIES IN THE STUDY OF RELATED TOPICS IN 2008-2019

Ranking	Journals	State	Number of Papers	Proportion of Literature (%)	IF of Periodical in 2018	IF of Periodical in 2019
1	BMC MEDICAL ETHICS	The UK	9	7.031	2.507	2.77
2	JOURNAL OF MEDICAL INTERNET RESEARCH	Canada	5	3.906	4.945	5.82
3	NANOETHICS	Netherland	5	3.906	1.359	1.53
4	PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A-MATHEMATICAL PHYSICAL AND ENGINEERING SCIENCES	The UK	4	3.125	3.093	3.26
5	COMPUTER LAW & SECURITY REVIEW	Netherland	4	3.125	1.552	1.39
6	BIOETHICS	The UK	3	2.344	1.665	1.76
7	FORENSIC SCIENCE INTERNATIONAL-GENETICS	Ireland	2	1.563	4.884	3.99
8	AMERICAN JOURNAL OF BIOETHICS	The UK	2	1.563	5.786	0.74
9	INTERNATIONAL JOURNAL OF SOCIAL ROBOTICS	Netherland	2	1.563	2.296	3.17
10	GENETIC TESTING	The US	2	1.563	1.121	1.09

The periodical ranking the third in terms of number of publications is NANOETHICS, which is focused on ethnic issues and has expanded its scope of discussion to physics, biology, social science and law. It was listed in Zone 2 of history and philosophy of science (Q2) by SCI of Chinese Academy of Sciences with the average IF of 1.014 in the recent three years and a total of 527 citation times in the

recent two years. The IF was 1.53 in 2019.

C. Analysis on Research Hot Spot

The author analyzed the internal structure of subject or theme research mainly using co-citation analysis and co-word analysis.

As a kind of bibliometrics method, Author Co-citation

Analysis (ACA) analyzes the citation of literatures published by different authors by other literatures so as to determine the relationship of research themes among different authors. A total of 128 literatures themed by “social risks and regulation of AI + medical” were chosen by CiteSpace5.0 R4 SE software in 2008-2019 with a slice length of 1 year. [2] The node type is “keyword” and “Reference”. There were 128 Records and 5,826 References (references of the 128

literatures), which are the latest research trend of the research objects. Term co-occurrence time map was drawn based on the characteristics of time evolution and finally 7 term clusters were formed. There were 356 keywords in the map, which formed 1,030 lines. There were 7 kinds of data generated, which displays the outline value of the largest two types (Mean Silhouette), #0robot therapist was 0.776 and #1 genetic testing-law was 0.763 (see Fig.2).

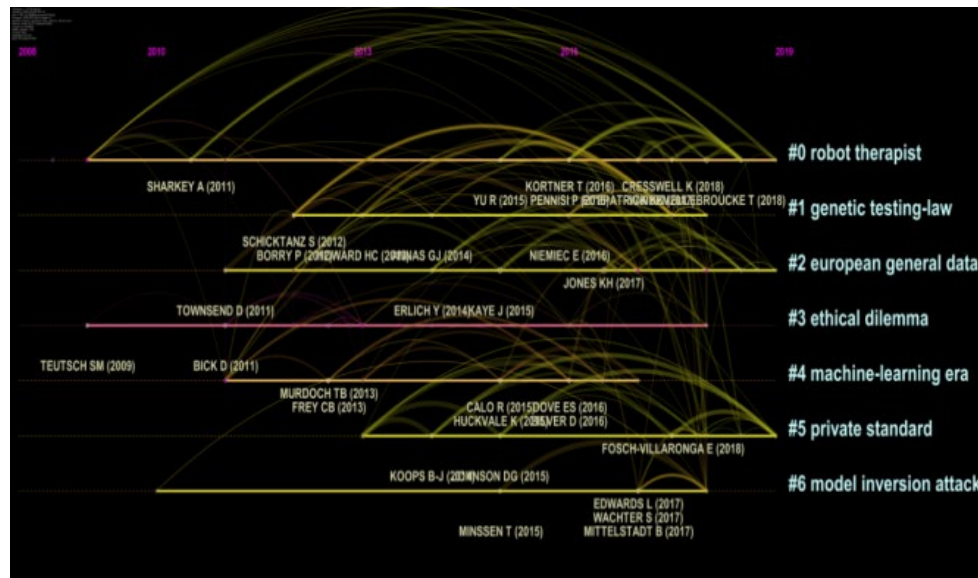


Fig.2. Timeline Diagram of Literature Co-citation Clustering

The layer of cluster formation was relatively clear. Cluster 0 mainly focuses on robot therapist while cluster 1 pays attention to genetic testing-low mainly. Such kind of research concentrates on the standard use of AI in medical field. The highlight on the therapeutic AI shall be a kind of medical product approved under proper approval procedure and moral code. [3] It has been commonly accepted the moral rule is still urgently needed in AI at present. With a strong focus on European general data, the research of cluster 2 pays attention to all countries and regions worldwide. To be specific, the US, China and Europe are the three regions with outstanding performance in AI field. With basic complete legislation with regard to medical data, the Europe and America highlight privacy protection. Cluster 3 is mainly focused on ethical dilemma and is transformed from the frontier technology to realistic application along with the development of AI medical treatment. Intelligent medical device can make decisions independently, just as we human does so scholars are apt to confirm the type of decisions they can make, the background with which they could make these decisions, the object that sets their decision parameters and how AI could make decisions conforming to social moral principles. EU has always taken the lead

worldwide in terms of research on AI ethnics and law. Cluster 4 mainly highlights machine-learning era. It has noticed that robot demonstrates their existence in a way that never occurs before. Machine learning automation is also one of the key exploration directions in recent years. Cluster 5 concerns on private standard mainly. Its standardization has become the research hot spot worldwide gradually along with the vigorous development of AI technology. The standardization of AI medical device, which is under the early stage at present, is mainly engaged in some basic work such as the building of standard framework and preparation of terminology standard. ISO, IEC, ITU and IEEE have established their standard research working team for AI medical device. All these teams have developed researches for years. Focus Group on Artificial Intelligence for Health (FG-AI4H) duly established by ITU and WHO plays a crucial role in standardization study. [4] Cluster 6 mainly concerns on model inversion attack. Such kind of research is mainly aimed at the influence of change of medical robot working environment on system model and verifying the effectiveness of the control strategy designed via simulation result. [5]

TABLE II. TOP 10 COUNTRIES IN IN THE STUDY OF RELATED TOPICS FOR THE AUTHOR 2008-2019

Ranking	Author	State	Record of Literature Publication	Citation Times
1	McCarty, CA	USA	1	323
2	Kayser, M	NETHERLANDS	1	114
3	Korf, BR	USA	1	69
4	Lee, SSJ	USA	1	56
5	Caulfield, T	CANADA	1	50
6	Hengstler, M	GERMANY	1	44
7	Kayser, K	GERMANY	1	36
8	Rotimi, CN	USA	1	35
9	Weng, YH	JAPAN	1	34
10	Villaronga, EF	NETHERLANDS	2	6

TABLE II shows that the literatures published in the field of research on “social risks and regulation of AI + medical” are from 5 countries, including 4 Americans and they were cited for 483 times in total. There are also two German and Netherlands and one Canadian and Japanese respectively. They published one paper respectively (TABLE II).

TABLE III. STATISTICS ON THE INFORMATION RELATED TO HIGH-FREQUENCY KEYWORDS IN THE FIELD OF RESEARCH ON “SOCIAL RISKS AND REGULATION OF AI + MEDICAL APPLICATION” OVER THE PAST ONE DECADE

Word Frequency	Centrality	Keyword	Year
20	0.35	ethics	2009
15	0.15	risk	2011
11	0.21	informed consent	2012
8	0.29	privacy	2017
8	0.25	information	2011
6	0.25	consent	2018
6	0.13	artificial intelligence	2018
5	0.04	issue	2018
5	0.08	science	2017
5	0.19	legal	2013

Keyword generally summarizes the essential point of a literature, concludes the author’s academic idea and points of view and serves as the key mark of literature inclusion and indexing. Co-occurrence word analysis method means determining the relationship among different themes in the discipline represented by such collection by using the

co-occurrence of central vocabulary pair of literature or noun phrase. The intensity of co-relationship among keywords reflect the research hot spot in the field of “research on social risks and regulation of AI + medical application” and serves as the research hot spot in the field and the key basis of the latest dynamics. TABLE III shows the keywords in the field of “research on social risks and regulation of AI + medical application” over the past one decade. It was concluded through analysis that the keywords with top rankings in terms of frequency of occurrence in this field and frequency are: ethics 20, risk 15, informed consent 11, privacy 8, information 8, consent 6, artificial intelligence 6, issue 5, science 5 and legal 5.

Timeline map mainly highlights the relationship of time among clusters. The node of the same kind of clusters is arranged along the same horizontal line based on time sequence so as to display the historical results of such cluster and activity of research. The co-word network formed by the association of these word pairs can be formed by making statistics on the frequency of occurrence between the subject terms of one group of literature. The map made via CiteSpace is the matrix passing COSINE, PMI, DICE and JACCARD standardization on the basis of the original matrix and then they are used for network virtualization. Term co-occurrence timeline map regarding the evolution of the research trend of the research object along with time (Fig.3) was drawn by using CiteSpace software and a total of 9 term clusters were formed.

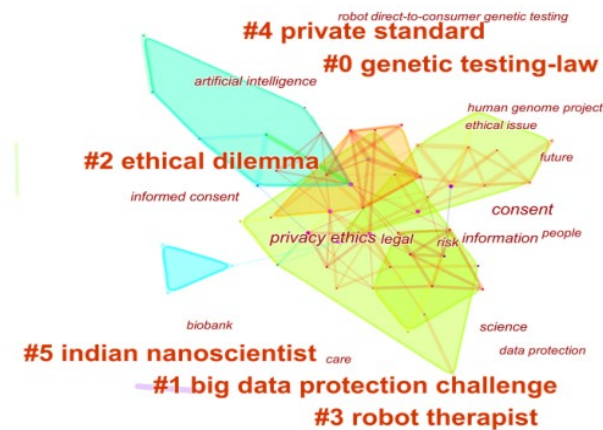


Fig.3. Timeline Map of Keyword Clustering

Cluster 0 is mainly focused on genetic testing-law. Such kind of research usually highlights the effective role of gene detection in such fields as public hygiene, precision medicine, pathogen detection and species identification and will pay more attention to the actual application of the fast and simple gene detection method. Some new issues regarding law and ethnics occur, while highlighting the new DNA sequencing information privacy in medical data collection end and AI application end. Such kind of research, technology and the reduction of detection costs using high throughput sequencing. These problems and hazards become more prominent in the context of consumers’ commercial gene detection without doctor’s guidance. Such kind of research appeared after 2003. By mainly concerning on big data protection challenge, cluster 1 is accompanied by the gradually mature big data mining and analysis method,

extensive application of AI technology in medical field, global concern of the problems of personal which appeared in around 2008, pays attention to medical privacy safety from technical, legal and ethnic perspective. Cluster 2 is mainly focused on ethical dilemma and is transformed from the frontier technology to realistic application along with the development of AI medical treatment. Intelligent medical device can make decisions independently, just as we human does so scholars are apt to confirm the type of decisions they can make, the background with which they could make these decisions, the object that sets their decision parameters and how AI could make decisions conforming to social moral principles. EU has always taken the lead worldwide in terms of research on AI ethnics and law. Such kind of research appeared in about 2014. Cluster 3 mainly focuses on robot therapist. Such kind of research concentrates on the standard

use of AI in medical field. The highlight on the therapeutic AI shall be a kind of medical product approved under proper approval procedure and moral code. It has been commonly accepted the moral rule is still urgently needed in AI at present. Cluster 4 concerns on private standard mainly. Its standardization has become the research hot spot worldwide gradually along with the vigorous development of AI technology. The standardization of AI medical device, which is under the early stage at present, is mainly engaged in some basic work such as the building of standard framework and preparation of terminology standard. ISO, IEC, ITU and IEEE have established their standard research working team for AI medical device. All these teams have developed researches for years. Focus Group on Artificial Intelligence for Health (FG-AI4H) duly established by ITU and WHO plays a crucial role in standardization study. Cluster 5, which mainly focuses on Indian nanoscientist, will become the foundation for future development with the development of such technologies as biology, information and nanometer. Scholars have noticed that India is using nanometer technology to research the applied equipment for such industries as medical treatment and industry. It has aroused mass's extensive concern on the nanometer safety such as whether the products made from nanometer materials, particularly the man-made nanometer material contacting or entering human body directly, could cause special biological effect or whether they do good or harm to human health and is safe to other organism and environment. The news that antibiosis nanometer robot may replace broad-spectrum antibiotic may exert huge influence on human's fight against the diseases resistant to drugs.

IV. CONCLUSION

A. Through WOS Retrieval the Author Found that there are Few Research Results Regarding "Social Risks and Regulation of AI + Medical Application"

The author made search and retrieval by taking the core set database of WOS as the data source. Retrieval formula ((TS = ethical issues OR TS = moral standards OR TS = supervision path OR TS = medical devices) AND (TS = legal* AND TS = risk*)) AND (TS = medical artificial intelligence OR TS = artificial intelligence robot) AND language: (English) AND literature type: (All document types) index = SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, CCR-EXPANDED, IC time span = 2000-2019; retrieval date: December 1, 2019. A total of 1 literature was retrieved only. By modifying the retrieval formula, the author concluded the current results through retrieval according to 2.1 specified above. The above fully demonstrates that there are few research results on "social risks and regulation of AI + medical", letting alone the literatures associated with the keywords such as "AI medical and risks, and laws".

B. Analysis on Research Hot Spot

The hot spot of researches related to social regulation and laws of AI in medical treatment can be fully seen in Fig.3 and TABLE III. 1) Some new issues of DNA sequencing technology in terms of laws and ethnics; 2) Personal information privacy at the medical data collection end and AI application end and medical privacy safety; 3) Decision-making of medical robot; 4) The standard application of AI in medical field; 5) Standardization of AI medical device; 6) Concerns on nanometer safety. Among all the issues above, the ethnic reorganization of doctor-patient

relationship of AI-aided medical treatment triggers extensive concerns. New technical challenges will come again in the AI-aided medical treatment, whatever the master-slave relationship or cooperative relationship of doctor-patient relationship. Scholars have noticed the issue on how to define and manage master-slave relationship under "human-machine" medical treatment mode. Two kinds of solutions have been proposed mainly by the ethicists at present: The first is to solve the morality of AI medical system. It designs the corresponding ethnic moral procedure for AI intelligent medical treatment so as to ensure the safety of AI intelligent medical treatment in its application process. The second is to solve the ethic relation between AI intelligent medical system and human, including the relationship between doctors, between doctors and patients and between doctor and society and how to determine the primary and secondary status between doctor and AI intelligent medical treatment under such relationship and how to determine the primary and secondary status between doctor and AI intelligent medical system under such relationship. The participation of AI intelligent medical system will bring more troubles to clinical decisions and more challenges to patients' rights, subjectivity and informed consent capacity.

C. EU Takes the Lead Worldwide in Terms of Research on AI Ethics and Law

The General Data Protection Regulation (GDPR) passed in the European Parliament through voting in April 2016 ensures the privacy of individual information data, which also provides certain standards and codes for the data and information processing in course of new technology R&D. Under the influence of EU's GDPR, the UK ratified Data Protection Act 2018, which supports the safe application of data in AI and machine learning greatly and contains some required guarantee measures to ensure strict regulations available to regulate the automatic processing process of data. Artificial Intelligence For Europe, the policy document issued by European Commission in April 2018 proposes the people-oriented AI development path to enhance EU's scientific research level and industrial capacity so as to cope with the challenges caused by AI and robot in terms of technology, ethnics and laws and enable AI to serve Europe's social and economic development better. EU launched two pieces of key critical documents, i.e., Ethics Guidelines for Trustworthy AI and A Governance Framework for Algorithmic Accountability and Transparency, respectively in April 2019.

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