ORIGINAL RESEARCH

Visualizing the History and Perspectives of Disaster Medicine: A Bibliometric Analysis

Xinxin Hao, PhD; Yunling Liu, MB; Xiaoxue Li, PhD; Jingchen Zheng, PhD

ABSTRACT

Objective: To analyze the development of disaster medicine and to identify the main obstacles to improving disaster medicine research and application.

Methods: A topic search strategy was used to search the Web of Science Core Collection database. The 100 articles with the highest local citation scores were selected for bibliometric analysis; summarizing informetric indicators; and preparing a historiography, themes network, and key word co-occurrence map.

Results: The 100 articles with the highest local citation scores were published from 1983 to 2013 in 9 countries, mainly in the United States. The most productive authors were Koenig and Rubinson. The lead research institution was Columbia University. The most commonly cited journal was the Annals of Emergency Medicine. The development of disaster medicine could be separated into 3 consecutive periods. All results indicate that the development of disaster medicine faces some obstacles that need to be addressed.

Conclusions: Research works have provided a solid foundation for disaster medicine, but its development has been in a slow growth period for a long time. Obstacles to the development of disaster medicine include the lack of scientist communities, transdisciplinary research, innovative research perspectives, and continuous research. Future research should overcome these obstacles so as to make further advances in this field.

Key Words: disaster medicine, bibliometrics, local citation score, historiography, obstacles

Disasters are "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources."[1] Disasters affect many countries in one way or another. In 2017, the Emergency Events Database indicated that 318 natural disasters occurred, affecting 122 countries. These natural disasters resulted in 9503 deaths, affected 96 million people, and caused US $314 billion in economic damages.[2]

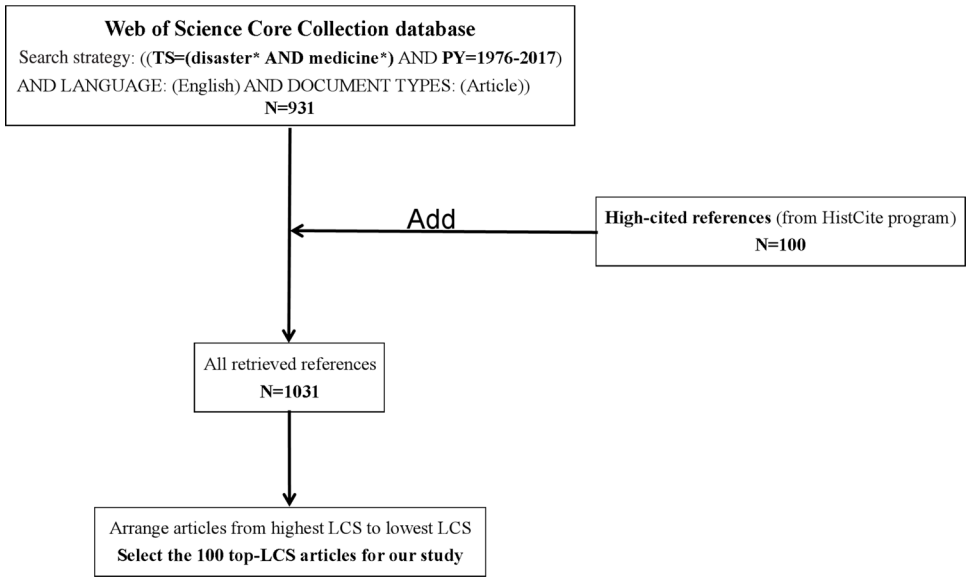
In order to foster optimal resuscitation and life-support methodologies, "the Club of Meinz" was founded in 1976 by 10 concerned resuscitation experts from 7 countries. In 1985, the club was renamed "World Association for Disaster and Emergency Medicine" to reflect the more global membership of the organization.[3] The past 30 years have witnessed the development of disaster medicine (DM), which has gradually extended into governmental actions based on academic studies in some countries.

Disaster medicine is defined as the study of the association between disasters (natural or man-made)[4] and human health. It is interdisciplinary and is related to such disciplines as sociology, management, and psychology.[5] Disaster medicine is the quest for efficient and reliable disaster relief. Under the ever-changing and dynamic circumstances, more generally, DM has been an integral component of disaster relief.

According to previous research, the development of scientific specialties, like that of most natural phenomena, takes the form of logistic curve.[6,7] This means that the development of DM is passing through the following series of periods: the initiation period, the rapid growth period, the slow growth period, and the platform period. In the initiation period, researchers make efforts to promote the development of DM to realize the rudiments. Then DM enters the rapid growth period with significant achievements, during which the fundamental theories are gradually improved with substantial contents, and more scientific methods are adapted. With the deepening of research, DM undergoes a bottleneck period with some obstacles, named the slow growth period. Researchers are expected to make breakthrough progress and overcome obstacles allowing the development of DM to enter the platform period. At present, DM has been at the slow growth period for a long time. It is of utmost urgency to identify the main obstacles to the further development of DM.

FIGURE 1

Flow Diagram of Study Selection



Abbreviation: LCS, local citation score.

As a useful supplement to other research evaluation measures,[8] bibliometric analysis has been widely used for evaluating the literature in different disciplines,[9] including 2 dimensions: quality (or performance) and quantity (or productivity).[10] Bibliometric analysis has been employed to reveal historical development and trends[11-13] with citation analysis[14,15] or with significant informetric indicators (ie, authors, institutions, countries, and journals).[16-18] In this study, a bibliometric analysis is conducted for analyzing the development of DM and identifying current obstacles.

METHODS

As a world-renowned academic publisher, Web of Science (WoS; formerly ISI Web of Knowledge) covered all available, authoritative, and professional research information. We retrieved all articles from the WoS Core Collection database, using the following search strategy: ((TS = (disaster* AND medicine*) AND PY = 1976-2017) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article). TS, which stands for topic, covered various types of disasters such as earthquakes, tsunamis, floods, drought, and famine. The abbreviation PY is short for year published; DM originated in 1976, as described in the Background section. We identified 931 peer-reviewed English-language articles during the period of January 1, 1976, through December 31, 2017. Then we added another 100 high-cited references with the aid of HistCite software. As a result, we retrieved 1031 articles.

Local citation score (LCS) refers to the citation score of an article inside the knowledge domain.[19] The number of LCSs an article receives is an important indication of its impact and contribution to DM. The higher the LCS an article has, the more likely it is to be described as seminal. There was a paucity of literature concerning top-LCS articles in the DM field. Thus, of the 1031 articles, we selected the 100 top-LCS articles for further analysis in this study (Appendix 1). See Figure 1 for a flow diagram of the study selection.

HistCite is a software tool for analyzing and visualizing direct citation linkages among articles.[19] Its inputs were bibliographic records (with cited references) from WoS. Its outputs were various tables and graphs with informetric indicators about the knowledge domain under study. HistCite software could export the historiography in a Pajek file format. Then UCINET software was used to transform the Pajek file format into an executable file format that can be directly imported into programs like VOSviewer. VOSviewer was used to construct maps of the 100 top-LCS articles based on co-citation data or to construct maps of key words based on co-occurrence data.[20] To ensure high data quality, we performed data cleaning in Trifacta Wrangler,[21] which changed or deleted singular-plural pairs and meaningless terms.

Using HistCite, we analyzed the 100 top-LCS articles (see supplementary online Appendix), constructed the historiography of DM, and summarized the informetric indicators. Then, using tools of UCINET, Trifacta Wrangler, and VOSviewer, we constructed a themes network and drew a key word co-occurrence map.

https://doi.org/10.1017/dmp.2019.31 Published online by Cambridge University Press

TABLE 1

Authors With 4 or More Publications on the List of 100 Papers With the Highest Local Citation Scores

Rank	Author	Publications, n
1	Koenig, KL	6
1	Rubinson, L	6
3	Prezant, DJ	5
4	Burkle, FM	4
4	Cohen, HW	4
4	Cone, DC	4
4	Kelly, KJ	4
4	Markenson, D	4
4	Pesik, N	4

TABLE 2

Countries with Publications on the List of 100 Papers With the Highest Local Citation Scores

Rank	Country	Publications, n
1	United States	78
2	Australia	4
2	Israel	4
2	Japan	4
5	Turkey	3
6	Canada	2
6	China	2
6	United Kingdom	2
9	Switzerland	1

RESULTS

Informetric Indicators

Of 1031 articles, the 100 top-LCS articles (Appendix) were published from 1983 through 2013 and had LCSs ranging from 5 to 32 times. The 100 articles had a total of 460 authors, of which 384 (83.5%) contributed to 1 article. In order to examine the concentration of author productivity, we listed the 9 most productive authors (publishing more than 4 articles) in Table 1. Koenig and Rubinson contributed the most articles (n = 6), and Prezant ranked third (n = 5), followed by Burkle (n = 4), Cohen (n = 4), Cone (n = 4), Kelly (n = 4), Markenson (n = 4), and Pesik (n = 4). Although these authors are commonly accepted as research pioneers, there was a lack of major specialist groups and key researchers in the DM field.

Table 2 shows the contributions of countries, and Table 3 presents the top 5 most-productive institutions (publishing more than 5 articles). The United States was the largest contributor (n = 78), followed by Australia (n = 4), Israel (n = 4), Japan (n = 4), Turkey (n = 3), Canada (n = 2), China (n = 2), the United Kingdom (n = 2), and Switzerland (n = 1). China was the only developing country in the list. Additionally, all of the top 5 institutions were located in the United States, and 3 of them were universities. The United States took a core position in the DM field, and there was a lack of key institutions.

Table 4 illustrates the commonly cited journals (publishing more than 1 article). The vast majority were high-quality and influential journals, which indirectly reveals that the 100 top-LCS articles we analyzed were the seminal papers in the DM field. Researchers can assess useful information about DM research from these journals. However, most of them were classified as emergency medicine periodicals; there was a lack of transdisciplinary research.

Historiography

In order to trace the dynamic changes in DM, we constructed the historiography of DM (Figure 2). The development of DM

TABLE 3

Institutions With 5 or More Publications on the List of 100 Papers With the Highest Local Citation Scores

Rank	Institution	Publications, n
1	Columbia University	11
2	New York University	10
3	US Centers for Disease Control and Prevention	9
4	Montefiore Medical Center	6
4	Yale University	6

was divided into 3 consecutive periods, namely the initiation period (1983-2001), the rapid growth period (2001-2010), and the slow growth period (2010 and onwards). Consistent with previous research,[22] the initiation period was a slow and painful but necessary process lasting 18 years. Then, in the next 10 years (2001-2010), rapid development was made in DM research. As we all know, the World Trade Center in New York was attacked unexpectedly by international terrorists on September 11, 2001. After that, experts and scholars stepped up efforts to work on DM research. In a sense, the September 11 incident was viewed as a milestone in the development of DM. During the 10-year period that followed, great progress was achieved, and the United States in particular contributed greatly to the growth and development of the DM field (ie, the Incident Command System[23]). Since 2010, DM has entered into a slow growth period. Only 12 of the 100 top-LCS articles were published in 2010 or later, although this may have been influenced by the publishing time. [24] What's more, there have been some obstacles to the further development of DM.

Research Topics

Co-citation cluster analysis, a technique based on counting the occurrences of pairs of references in the reference lists of scientific publications, has become a popular and widely used method of assessing articles in recent years.[25] Preliminary

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TABLE 4

Journals With 2 or More Publications on the List of 100 Papers With the Highest Local Citation Scores

Rank	Journal	Frequency, n	IF[a]
1	Annals of Emergency Medicine	12	4.680
2	Academic Emergency Medicine	9	2.612
3	Environmental Health Perspectives	7	8.309
4	Disaster Medicine and Public Health Preparedness	6	1.220
4	New England Journal of Medicine	6	79.258
6	Annals of Surgery	5	9.203
6	Pediatrics	5	5.515
8	Journal of the American Medical Association	3	47.661
8	American Journal of Respiratory and Critical Care Medicine	3	13.204
8	Journal of Trauma and Acute Care Surgery[b]	3	3.695
11	Academic Medicine	2	4.801
11	Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science	2	—
11	Critical Care	2	6.425
11	European Journal of Emergency Medicine	2	1.729
11	Injury: International Journal of the Care of the Injured	2	2.199
11	Psychiatry: Interpersonal and Biological Processes	2	2.186

[a]2017 International Scientific Indexing Impact Factor.
[b]Formerly the Journal of Trauma Injury Infection and Critical Care.

analysis showed that 12 out of the 100 articles were independent and had no connection to the others. The themes network of the remaining 88 articles, as shown in Figure 3, was divided into 9 clusters:

1. Environment and occupational health—rescue workers in the September 11, 2001 attacks (firefighters' respiratory system)
2. Posttraumatic stress disorder
3. Public health—bioterrorism, epidemic
4. Earthquake—the care of crush-related injuries and surge capacity[a]
5. Triage—medical triage,[b] psychosocial triage[c]
6. The principles of emergency rescue
7. Emergency medical responders
8. Training and education—medical students, all health professionals
9. Pediatric disaster medicine

[a]The ability to manage a sudden, unexpected increase in patient volume that would otherwise severely challenge or exceed the current capacity of the health care system.
[b]The separation of patients based on severity of injury or illness in light of available resources.
[c]The separation of patients based on the severity of psychological injury or impact in light of available resources.

Key words, including author key words and key words plus,[26] can reveal the research trends and topics.[27,28] They are category labels given by authors and act as a significant liaison between authors and readers. Key word analysis reveals the main themes of DM research.[29] A total of 498 key words were included, of which 52 were extracted for mapping key word co-occurrence (occurrence frequency higher than 3) according to Price's law.[30] The common terms were *disaster*, *bioterrorism*, *management*, *terrorism*, and *disaster medicine*. In comparison, *firefighters* and *follow-up* were relatively new terms.

The key word co-occurrence map (Figure 4) is consistent with the themes network (Figure 3). The research topics within DM have established a solid foundation, and all key words have formed a comparatively intact research chain.

DISCUSSION

Obstacles to the Development of Disaster Medicine

As can be seen in the historiography (Figure 2), the development of DM has been in the slow growth period since 2010, and the field faces some obstacles.

Lack of Scientist Communities

Scientist communities are the core elements of scientific research.[31] In this study, scientist communities refers to the major specialist groups and key researchers and institutions working on DM research; these are the source of the construction and development of DM. Of 460 authors (of the 100 top-LCS articles), 384 (83.5%) contributed only once; there are no obvious major specialist groups and key researchers. In terms of the contributions of countries, developed countries gain the advantage over developing countries. In addition, the publication outputs are concentrated in a few institutions, with no obvious key institutions. These results suggest a lack of scientist communities in the DM field.

Lack of Transdisciplinary Research

As we all know, DM is a comprehensive subject that combines wide-ranging fields such as medicine, management, and psychology.[5] Transdisciplinary research can broaden the knowledge domain and promote the development of related disciplines and enhance their influence on academic progress. With respect to the commonly cited journals, most of them are emergency medicine periodicals. This is frankly unfavorable to the linkage and common development of related disciplines as well as inimical to the influence of the field on academic progress.

Lack of Innovative Research Perspectives

Although almost all the cases studied are classic, they are too monotonous, such as the September 11 attacks and the Hanshin-Awaji earthquake. This is an example of *herd*

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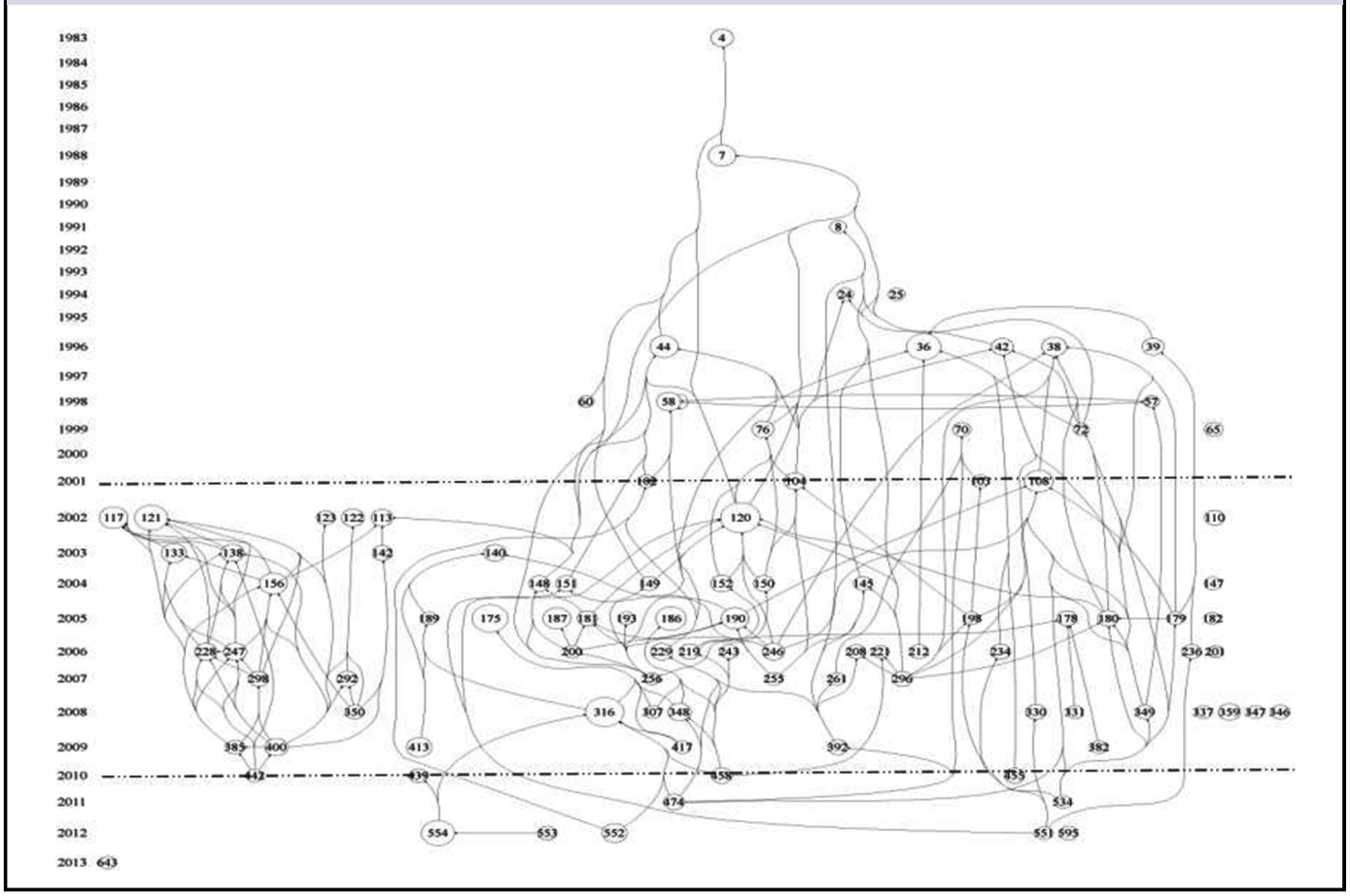
FIGURE 2

Historiography of Disaster Medicine



Each circle represents an article; the number inside the circle is the article's serial number. The size of the circle represents citation frequency, and the arrow indicates the direction of citation. A list of the 100 papers can be seen in supplementary online Appendix.

behavior. In addition to these cases, there are, of course, many other significant events that deserve to be explored in depth. They may be very similar to the classic cases, but including them will add valuable comparison and detail to the research. With regard to research topics or themes, most concentrate on injury, preparedness, trauma, and care, as expected. The results undoubtedly illustrate a lack of innovative research perspectives in the DM field.

Lack of Continuous Research

Examination of key words reveals 498 key words appearing in the 100 top-LCS articles, 383 (76.9%) of which were used only once. According to Chuang et al. (2007),[32] this pattern indicates that most scholars lack continuous research and there is a wide disparity in research focuses. Lack of continuous research will inevitably influence the quality of research, cause inefficient use of research resources, and ultimately hinder the development of DM.

As suggested by Gupta et al. (1995),[6] researchers must address these obstacles broadly and systemically to move the field into the platform period. Focusing on current obstacles, we put forward some proposals.

Strategies for the Development of Disaster Medicine

Accelerate the Development of Scientist Communities

Scientist communities are the aggregate of major specialist groups, key researchers, and institutions. To accelerate the development of scientist communities, we must first improve information and knowledge sharing. To our knowledge, DM is a new and rapidly progressing discipline,[5] in which many unexplored areas are worthy of being examined and conquered by researchers. Some authoritative research institutions should establish a mechanism for information and knowledge sharing regarding DM. This will expand the influence of DM and attract the ever-growing attention of researchers in related

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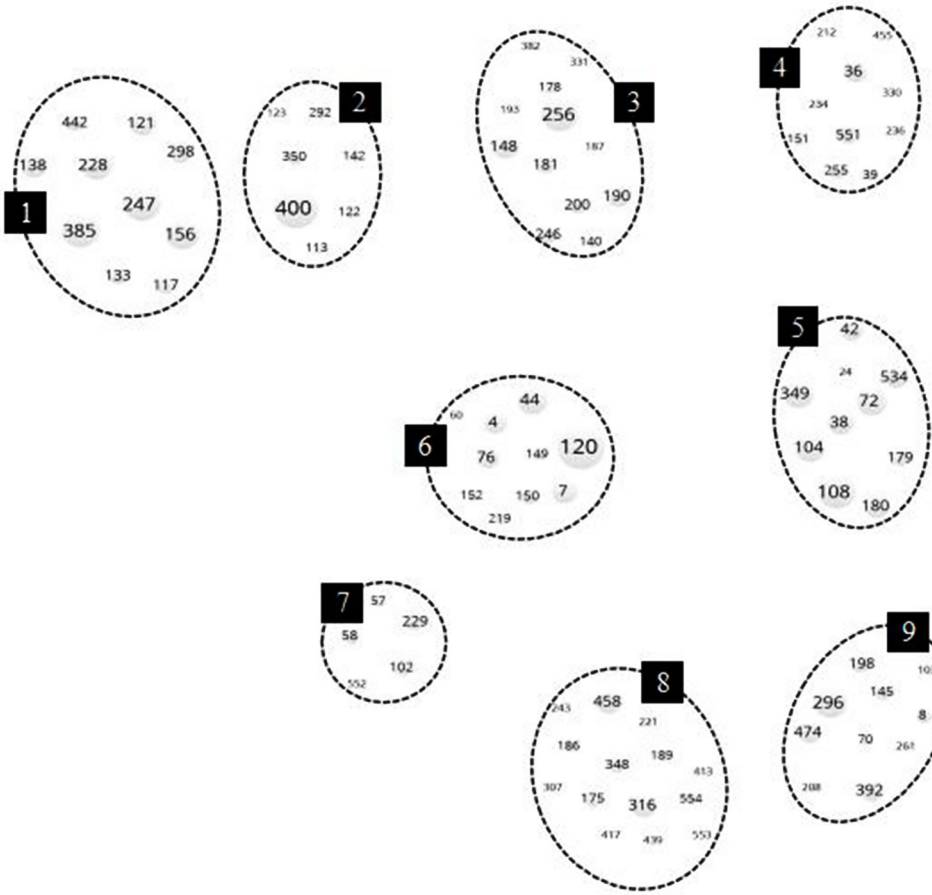
FIGURE 3

Themes Network



The number inside the circle is the article's serial number, and the size of the number represents the co-citation frequency. The number inside the black box indicates the co-citation cluster.

areas, thus accelerating the development of scientist communities. Secondly, we must promote the "civil-military integration pattern." In most countries, as Burkle et al. (1984)[33] delicately put it, the military seems to have the only system which is always ready and funded to provide instant communication, short response time, trained medical personnel, needed equipment and supplies, airlift capability, extrication and rescue technology, and authoritative leadership and organization, which are required for the resuscitation of victims of mass disasters. There are more opportunities for military institutes to obtain abundant and valuable relevant information in the DM field; however, none of the 100 top-LCS articles are from relevant military institutes. Researchers should place stress on the promotion of the civil-military integration pattern, as well as the development of scientist communities. Last but not least, developing countries should intensify DM research and cultivate more (essential) professionals. In China, for example, the Ministry of Education has not yet promulgated a complete DM education plan, namely curriculum design, training pattern, teaching quality standards, etc. Quite evidently, there is an urgent need for an organized professional training program to be proposed.

Strengthen Transdisciplinary Research

Transdisciplinary research makes the development of DM break through traditional spatial and temporal limits and enables DM to integrate knowledge from other fields (management, psychology, sociology and organizational behavior, etc).[34] To facilitate transdisciplinary research, we should construct superior subject-groups with multiple basic disciplines. This will not only optimize the subject structure, but also advance the development of related areas.

Open Innovative Research Perspectives

A classic case has its own value, as well as realistic limitations. Similarly, the perspective of authoritative study also has its own limitation. Many disasters occur in the world every year,

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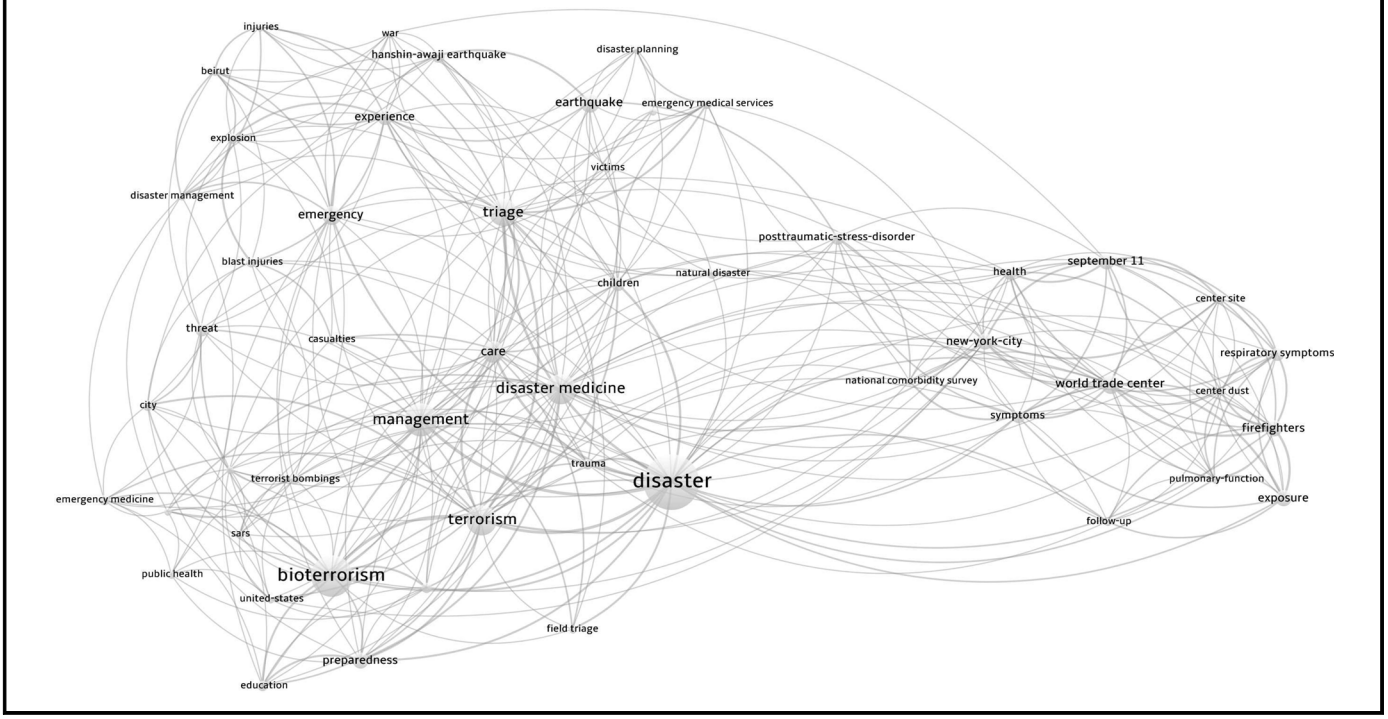
FIGURE 4

Key Word Co-occurrence Map



Each label represents a key word. The size of the key word represents the co-occurrence frequency. The lines indicate key words simultaneously appearing in 1 article.

and none are identical. However, researchers often ignore their own respective characteristics through a simple classification. Researchers should not be afraid of speaking their mind, not follow others almost blindly, and then make some breakthroughs in the DM field.

Increase the Continuity of Research

Researchers should place more emphasis on continuous research by providing consistent funding for research and training programs.[32] The shortage of scientific research funds is a general problem, but unsuitable investments and waste still exist in the investment of the limited funding. Thus, funding should be used to support scientist communities, improve the quality and efficiency of research, and increase the continuity of research.

Limitations

Two limitations should be considered in our study. One is the omission on the contributions of coinstitutions and/or cocountries. In this study, we only summarize the main contributions provided by institutions and origin countries of the first authors. Additional research should be able to cope with this limitation. Another is that we retrieve articles from WoS Core Collection database with TS strategy. Future research can replicate our study in other databases with some key words or TS strategy.

CONCLUSIONS

Under the complicated background of disasters, DM has become an increasingly important hot topic in the wider medical community. Dealing with the 100 top-LCS articles, our study proposes some significant points on the worldwide research trends of DM. So far, DM has undergone 3 periods, that is the initiation period (1983-2001), the rapid growth period (2001-2010), and the slow growth period (2010 onwards). It has been at the slow growth period for a long time. Some deficiencies severely impede its further development, mainly in 4 aspects: scientist communities, transdisciplinary research, innovative research perspectives, and continuous research. As our study suggests, multiaspect, scientific, and effective measures should be taken to overcome these shortcomings: accelerate the development of scientist communities, strengthen transdisciplinary research, open innovative research perspectives, and increase continuity in research. Although impaired by certain limitations, our study will, we hope, inspire new studies on DM in the future.

About the Authors

School of Public Health, Fudan University, Shanghai, China (Drs Hao and Zheng); Department of Precaution and Healthcare, Da Meng Zhuang Town-Level Health Centers, Wuqing District, Tianjin, China (Ms Liu); Department of Modern Hospital Management, The Third Medical Centre, Chinese People's Liberation Army General Hospital, Beijing, China (Drs Li and Zheng).

https://doi.org/10.1017/dmp.2019.31 Published online by Cambridge University Press

Correspondence and reprint requests to Jingchen Zheng, School of Public Health, Fudan University, Shanghai 200032, China (e-mail: 64510521@qq.com).

Acknowledgments

My sincere thanks to my supervisor, who always supported my study and proposed many valuable suggestions for me. Thanks to Peng Tian for checking language. Then, I'd like to commemorate my dear grandmother with this paper, who passed away during my research, and give very special thanks to her for accompanying me until the final moment of her life.

Author Contributions

Xinxin Hao contributed with study design and wrote the original article. Xinxin Hao and Yunling Liu did the data acquisition. All authors contributed to the discussion and interpretation. All authors approved the final manuscript to be published.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this paper.

Funding

No specific funding source was utilized to support development of this manuscript.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/dmp.2019.31.

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