EMPHE Research

Subjects: Management | Pathology
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The Coronavirus Disease 2019 (COVID-19) infectious pneumonia pandemic highlights the importance of emergency management of public health emergencies (EMPHE). This paper addresses the challenge of building a knowledge system for EMPHE research that may contribute to understand the spatial and temporal characteristics of knowledge distribution, research status, cutting-edge research and development trends, and helps to identify promising research topics and guide research and practice of EMPHE. Based on the Web of Science, this paper retrieves 1467 articles about EMPHE published from 2010 to date. Then, based on high-frequency keywords, we use CiteSpace to analyze their knowledge co-occurrence network, clustering network and knowledge evolution. Furthermore, we summarize the features and gaps in EMPHE research, providing references for future research directions. Based on the above analysis, this work constructs a knowledge system about EMPHE research, providing a comprehensive visual summary of the existing research in the field of EMPHE, with the aim to guide future research and practice.

Keywords: emergency management ; public health emergencies ; knowledge system ; CiteSpace

1. Introduction

On the basis of the above bibliometric results, this work further summarized features and gaps of EMPHE research through extensive reading of the related literature, WHO reports and other official materials. By comparing public reports and media disclosures with the current research, several feasible countermeasures have been put forward.

2. Agility of Emergency Response

Emergency response is a key research paradigm in the EMPHE field. It is considered an important part of the PHE management system [1]. In 2018, the WHO released a report on integrated scientific interventions to respond to PHE response in epidemics and pandemics, which states the importance of emergency preparedness by emergency departments and community involvement in the emergency response to PHEs, and highlights the agility of the emergency response as a key factor. Agility, in this sense, means swift and effective. Due to the public characteristics of PHE, it is necessary to consider the participation rights and responsiveness of multiple actors, to maximize the public interest and thus maintain social stability [2]. Gillespie et al. [3] takes the Ebola pandemic as an example to confirm that it is necessary to include community participation and social mobilization into the PHE response system to promote the flexibility of the emergency response and better adapt to actual local needs. Lurie et al. [4] emphasized multiple levels of preparedness activities to achieve agility in coping with the uncertainty of PHE, including community participation, abnormal situation surveillance and detection and effective deployment by emergency departments. Based on the above analysis, emergency preparedness, community participation and social mobilization form the basis for ensuring the agility of emergency response to PHE. However, by further digging into the bibliometric results and extensive reading of the related literature, two weak points have been found in this area. This paper tries to meet the challenges with feasible countermeasures.

First of all, we are concerned that current studies on the agility of emergency response are mostly based on qualitative research related to textual analysis or case study analysis to describe the status quo and reasons for this. Their recommendations are often too narrow or too broad to be extensively applied—for example, Gillespie et al. [3] analyzed the Ebola outbreak in Guinea, Liberia and Sierra Leone, and it is hard to apply the conclusions obtained to other countries or other PHEs; Lurie et al. [4] reviewed the challenges of 10 PHE cases to identify key elements of emergency response measures and designed a PHE response system based on this; however, the construction of such an emergency response system is too broad, resulting in less feasibility. Thus, the advancing methodology should take a noteworthy direction when the related research is conducted. Applying quantitative and qualitative approaches in one study can achieve complementary advantages, and qualitative analysis based on quantitative description can reveal and explain more profound reasons. Therefore, it is necessary to combine quantitative and qualitative research in future research to

explore the improvement of emergency response to PHE. Mathematical function-based modeling and simulation tools may be the focus of attention in the future. Such technology can better ensure the stability and practicability of the emergency response system for PHE. For example, the β-distribution model is capable of modelling and simulating the risk perception of social public opinion, and it has been applied in machine learning and mathematical statistics [5]. It refers to a set of continuous probability distribution density functions defined in (0,1), which can be used to represent the posterior probability distribution of binary events. The β-distribution model provides a reliable mathematical basis for confirming the credibility of information feedback, and further make a better emergency response in the early stage of PHE.

Secondly, as outlined above, emergency preparedness by emergency departments and community involvement have been growing in importance in more and more countries, while the quality and ability of emergency department officials and community workers in many countries have not yet reached the level to make agile judgments about PHE situations [6][7]. It can be understood that if the relevant staff lack the expertise and ability related to EMPHE, it is difficult for them to play their part in EMPHE, and may even lead to unnecessary losses due to human errors, which may lead to risk and unnecessary loss. However, there are no keywords that relate to human error in the high-frequency keywords (Table 1) and time zone, indicating insufficient attention paid to this aspect. A preventive risk management tool based on the principles of Hazard Analysis and Critical Control Points (HACCPs) should be a way to reduce the probability of human error and, furthermore, to prevent the outbreak of PHE. Although the principles of HACCPs were originally created for the food industry, they have been successfully applied to risk management in a large number of disciplines [8]. They contribute to confirming the desired workflow and avoiding possible troubles that may lead to avoidable risks [9]. Designing a specific and reliable EMPHE process can make it easy to do the right thing and hard to do the wrong thing [10] through clarifying responsibilities and the EMPHE operating process, thus reducing human-caused risks. The HACCP should be developed by the WHO, who employ the top experts from around the world. Therefore, the most professional advice possible can be proposed and the different EMPHE strategies can be developed according to the actual situations of different countries. The WHO also has the responsibility of contributing to avoiding the spreading of PHE around the world. Some scholars have proposed that, in normal periods, attention should be paid to the training of emergency management departments and community workers, and carrying out regular assessments [11].

3. Timeliness of Protective Treatment

There is no doubt that protective measures are necessary to protect public health in PHE. The current research has been mainly carried out from the perspective of clinical medicine and medical staff management.

Although vaccines are the fundamental way to resolve many PHEs, it is difficult to develop specific vaccines for many diseases. Taking COVID-19 infectious pneumonia as an example, the current main means of prevention and control are cutting off the route of transmission. However, such methods are very costly, need to find close contacts through various channels, and may lead to large numbers of people being isolated, even posing risks of global economic downturn, devaluation of the currencies of many countries, and high mortality rates. Countries should establish a multi-national expert research & design (R&D) cooperation network and work together to jointly develop effective vaccines and other treatment medicines to jointly cope with COVID-19.

In addition, Gao et al. [12] found that there are problems, such as irregular sample collection and processing, different test reagent quality, and high false negative rates in monitoring results, making the prevention and control of PHE a serious hidden danger. Therefore, it is necessary to formulate strict standards before the onset of PHE and reserve qualified sample detection tools, so that after the onset of PHE, the source of infection can be identified in time and effective protection and treatment can be employed.

Finally, from the analysis of the time zone, was found that scholars are more enthusiastic about the timely PHEs. With the end of a PHE, the enthusiasm of scholars also diminishes. However, the end of a PHE does not mean the completion of scientific research—for example, after the end of the Ebola pandemic in 2016, studies on Ebola have rapidly declined, but the Ebola pandemic made a comeback in 2019, causing more than 2000 deaths in the Republic of Congo alone, demonstrating the necessity for continuous scientific research on a pandemic, rather than only deeming pandemic as short-term incidents. In actual fact, there is a valuable common experience that can be summarized from different PHEs. For instance, Liu and Cao [13] designed countermeasures for the COVID-19 infectious pneumonia pandemic from the experience of malaria prevention and treatment. Richards [14] proposed how to scientifically reduce the mortality rate of contact infectious diseases through a long-term study on the Ebola pandemic in West Africa. These studies will provide references for the study and handling of other infectious diseases. Thus, past experience is still valuable for coping with PHEs. Hope [15] classified PHE into three different types according to their causes, namely weather events, influenza

pandemics and bioterrorism events, which provide a reference for further research on the relationship between different PHEs. It is necessary to carry out detailed research on the characteristics and nature of these types of PHEs to find some rules and laws from the pandemic phenomenon.

4. Guarantee of Necessary Supplies

The guarantee of necessary supplies can be reflected in two aspects, which are respectively medical supplies and living supplies. Medical supplies provide important guarantees for the effectiveness of protective treatment, while living supplies are the basis for ensuring people's livelihoods. Some scholars think about the guarantee of necessary supplies from the perspective of supply chain optimization. For example, Ajrawat et al. [16] describes the development of decision support tools to assist the Center for Disease Control and Prevention's Strategic National Reserve Division to ensure the timely supply of necessary supplies. Clausonc et al. [17] suggests further strengthening the block chain technology to increase the efficiency of the necessary supplies for EMPHE. Although scholars have examined the role of the supply chain, it is only one factor related to the guarantee of necessary supplies. The supply reserve, supply capacity and price stabilization in an emergency should also be attached importance by examining theoretical developments and practice improvements in related fields.

On the one hand, the theoretical development should be fully considered. The guarantee of necessary supplies is essentially a reflection of the government's supply capability. In 2015, the *Academy of Management Journal* (an authoritative journal in the management field) published an article that called for the reconstruction of risk management theory from the perspective of resilience [18], to cope with the complexity and uncertainty of PHE risks, and improve our ability to respond to emergent public events. Some scholars have used resilience thinking combined with supply chains to study the flexibility of material supply, internal and external resource integration, and risk management (e.g., [19]). Some scholars also described the use of social media to increase the resilience of communities in the EMPHE field from the perspective of community resilience [20]. After extensive reading, this study finds that the current research on the resilience mechanisms of risk management mainly focuses on natural hazards such as floods, forest fires and hurricanes (e.g., [21][22][23]) or management of public risks against emergent human factor-induced hazards such as chemical spills (e.g., [24]). Some scholars have demonstrated the significance of resilience mechanisms in risk management in improving EMPHE plans in small-scale areas through sample experiments [25]. In view of the above, the idea of incorporating the resilience mechanisms of risk management into EMPHE shows promise.

On the other hand, the practice still has large scope for improvement. Given the lack of effective vaccines for many PHEs [12], quarantine is one of the common approaches for stopping the spread of a virus. How to coordinate supply and demand during quarantine periods is a key point to be considered in the practice of EMPHE. Understandably, both medical supplies and living supplies may be in short supply to some extent in the initial days of quarantine. Governments should pay attention to supervise the market and stabilize prices. Donations from diverse sources can be managed through online cloud platforms. Some internet giants (such as Alibaba, Tencent, and Jingdong) can operate such platforms.

5. Effectiveness of Public Psychological Intervention

As mentioned earlier, the keyword "public health" should include public psychological health and physical health. Bibliometric analysis indicated insufficient attention to public psychological health and psychological intervention in PHE. According to the definition of a PHE, it also requires the timeliness, publicity, and the communication of relevant information [26]. Scholars have widely discussed the mental health problems of medical staff and put forward corresponding countermeasures [27][28], but there is lack of exploration of public psychology. However, in the sensitive context of PHE, the public require information, and the government information disclosure system has become an important tool for reducing public panic and anxiety [29]. In particular, the development of the all-media era has facilitated the dissemination of misleading and prejudicial information [30][31]. The public often lacks the ability to think rationally, and is easily misled by misinformation. This will further deteriorate the psychological problems such as anxiety and panic in PHE. Thus, managers of EMPHE should pay attention to public psychological interventions and the following suggestions are proposed.

Firstly, the psychological problems of the public, such as anxiety and panic, may be caused by inadequate knowledge about a PHE. Timely information disclosure and public opinion guidance by the mainstream media are important to effectively intervene in the psychological problems of the public [29]. With the development of network communication, the channels for the public to receive relevant information sources have been expanded. In the case, it is necessary for the

government to establish multiple information communication channels and online health guidance to better publicize the relevant knowledge of PHE in time, so as to avoid unnecessary panic, and make the pandemic information more transparent.

Secondly, public psychological health has not been valued in many countries. Hu et al. [6] pointed out that, due to the defects of emergency management mechanisms and policy, governments cannot effectively deal with public psychological problems during PHEs, especially in the rural areas of developing countries. It is necessary to establish permanent emergency management institutions with public psychological health management functions. In normal times, such departments can carry out the popularization of EMPHE knowledge to promote the participation of the public; in emergency times, such departments can be devoted to coping with public psychological problems during PHE to minimize social anxiety. Furthermore, it is meaningful to establish network communication mechanisms involving governments, volunteers, community managers and experts to communicate with the public during PHE, so as to mobilize all available social resources to effectively solve the public's psychological obstacles. Society as a whole also needs to increase support for psychological health, consulting the industry and calling on the public to pay attention to psychological health.

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