Proceedings of the 3rd International Conference on Signal Processing and Machine Learning
DOI: 10.54254/2755-2721/5/20230546

Analysis of the practical application value and practice path of big data in epidemic warning

He En

Maple Leaf School, Toronto, Ontario, Canada, M1S 4R5

enhemaster@163.com

Abstract. Late in 2019, the unique viral disease coronavirus disease, or COVID-19, initially appeared. On March 11, 2020, the World Health Organization (WHO) proclaimed the COVID-19 outbreak a pandemic. It rapidly spread to every corner of the globe. This paper examines the use and actual application of big data in epidemic early warning. Based on the analysis of the value of big data epidemic early warning mechanisms, this paper divides the current big data epidemic early warning systems into three main categories according to the various channels of data acquisition: early warning systems based on the Internet and communication systems, early warning systems based on electronic medical information, and early warning mechanisms based on the Internet of Things information collection.

Keywords: public health event, big data, artificial intelligence, early warning mechanism, COVID-19.

1. Introduction

The coronavirus illness, or COVID19, emerged for the first time in late 2019 [1]. On March 11, 2020, the World Health Organization (WHO) proclaimed the COVID-19 outbreak a pandemic. It rapidly spread to every corner of the globe. The COVID-19 pandemic began in China, the world's most populous nation, swiftly spread, and caused numerous civilian deaths worldwide [2]. In recent years, the widespread adoption of big data technologies in a variety of industries has generated significant social advantages. The government can establish an effective epidemic warning system by analyzing a massive amount of medical data, including daily data, and monitoring the spread of the virus and infected persons in real time. The big data epidemic warning mechanism has more blatant advantages than the conventional system, which requires governments at all levels to invest a substantial amount of manpower, material resources, and financial resources to isolate, sequence, and test viruses to determine whether the virus is human-to-human infectious and to estimate the speed of virus transmission [3].

This paper examines the use and actual application of big data in epidemic early warning. On the basis of the analysis of the value of the early warning system and the various data acquisition channels, the current big data epidemic early warning mechanism can be divided into three categories: the early warning system based on the Internet and communication system, the early warning system based on electronic medical information, and the early warning mechanism based on the Internet of Things information collection. Through the analysis of the monitoring system's data, exceptions can be

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identified in advance, suspected cases and close contacts can be quickly identified, and related data can be used to precisely calculate the extent of the epidemic's spread, the diffusion range, and the characteristics of the infection. Nationally, big data is being used to develop an early warning and monitoring system that operates in real time. Big data can be used to track the progression of an epidemic in real-time, thereby significantly accelerating government response times and providing the government with the necessary, comprehensive, and trustworthy information to combat the epidemic, administer treatment, and prevent economic losses.

Big data will surely play a crucial part in the development and combined use of artificial intelligence, 5G, the Internet of Things, and blockchain technologies, as well as in the fight against COVID-19 and the creation of crucial early warning systems for humans to prevent future outbreaks. This paper's material can be used as a roadmap for enhancing the worldwide public health emergency system.

2. Big data epidemic early warning mechanism is highly efficient

The efficiency of Big Data's epidemic alarm system may be demonstrated in both the early detection and early warning phases: firstly, early epidemic detection. Traditional epidemic warning response techniques sometimes do not recognize the severity of an outbreak until after a considerable number of individuals have been ill, or even after an infection has developed among health staff. Big data is a proactive early warning system that can discover hidden threats by computing the association between a small number of infected persons and evaluating whether or not the virus is contagious. In addition, it can analyze in real time the number of infected individuals, the source of infection, the transmission channel, and the transmission scope. Consequently, the government can respond much more quickly. On the flip side, an outbreak can be detected faster. In order to prevent the disease from spreading, it is necessary to track and identify the movement of confirmed cases, suspected cases, and close links as soon as an epidemic begins. Before the advent of big data, government officials were often expected to do door-to-door searches, complete multiple paper forms, and then aggregate the data. This approach was inefficient, unfocused, and incapable of real-time updates. By utilizing big data technologies, we can rapidly conduct a comprehensive digital survey and replace human resources with data. It is possible to analyze the personal information of confirmed cases and their activity trajectories in order to rapidly discover the personal information of relevant close relationships and avoid secondary transmission. Second, by integrating facial recognition systems, Internet of Things technology, artificial intelligence systems, and infrared sensors in crowded areas like as train stations, airports, and shopping malls, suspects may be rapidly detected and their personal information can be collected. The suspect cases can then be examined and quarantined to avoid the spread of the virus.

3. Low cost of big data epidemic warning mechanism

During the SARS outbreak in China, the effectiveness of prevention and control was hampered by the existence of numerous departments with unclear roles and authorities, and the analysis of the epidemic was susceptible to the whims of local administrative leaders and the lack of high-level, qualified virus researchers in certain regions. In the era of big data, data is becoming a key component of production, alongside physical assets and human resources [12]. Theoretically, the use of big data for epidemic prevention and control only requires a small number of data analysts to be applied nation-wide, which will further reduce human resource costs as artificial intelligence develops. In other words, the creation of a big data epidemic early warning system will not only support the reform of the healthcare system and a change in the way the government governs, but it will also increase productivity when high technology is applied and eliminate the need for additional administrative agencies to participate, a large administrative workforce, and extensive infrastructure, all of which can result in substantial cost savings.

4. Accuracy of big data epidemic warning mechanism

Considering the coronavirus to be an example, the new coronavirus has an incubation period; therefore, even though the epidemic outbreak appears to have happened rapidly, the source of the infection and the pace of transmission must be recognized and forecasted soon by epidemic prevention and control organizations at all levels. In the practice of epidemic prevention and control, it is impossible to quickly collect precise data on the existence of an outbreak, the extent of its spread, and the number of affected individuals. This raises confusion among government agencies as to whether they should issue a public epidemic warning and, if so, to what extent and with what epidemic response mechanism. sho u By analyzing the relationship between data, big data for epidemic warning replaces the subjective and empirical judgment of medical personnel, and the resulting conclusions are not susceptible to the whims of local government administrative authorities. Moreover, big data epidemic monitoring relies on real-time analysis of a vast amount of personal data, allowing many data sets to swiftly and with a low probability of error corroborate with one another. Using precise data information, government agencies can set up medical staff and supplies and take reciprocal measures to avoid epidemics without over- or under-preventative measures.

5. Early warning mechanism based on Internet and communication system

People will unavoidably exchange crucial information via phone conversations, text messages, emails, Facebook, Twitter, and other channels, or by looking for certain terms on search engines such as Bing and Google when a significant epidemic begins to spread among the population in the Internet age. We can predict and prevent the epidemic to a certain extent by searching for epidemic-related key terms in communication information and Internet search engines, determining their frequency, and comparing it to data collected during the disease's previous outbreak.

The interest in public information platforms has increased as the market for smart city applications has become more complex. The government completely integrates and shares all information types, encourages collaborative preventive and control mechanisms, and implements precise policies based on big data technology [5]. By creating a public information portal, residents can learn more about the state of the development and event requirements. A province in China has a Public Information System (see Figure 1) via which the administration communicates the number of confirmed cases to the Centers for Disease Control and Prevention. As the pandemic advances, the Centers for Disease Control and Prevention advise select hospitals to treat patients and alert the public through television news, digital media, and other channels. Residents can simultaneously assess the state of local epidemics and relevant policy requirements, and the Public Information System is needed to work with policy publicity. The government has also conducted an investigation, adopted preventative and containment measures, and provided residents with the necessary material aid. Visual maps of epidemic conditions can be viewed on mobile devices using a variety of mobile apps [4].

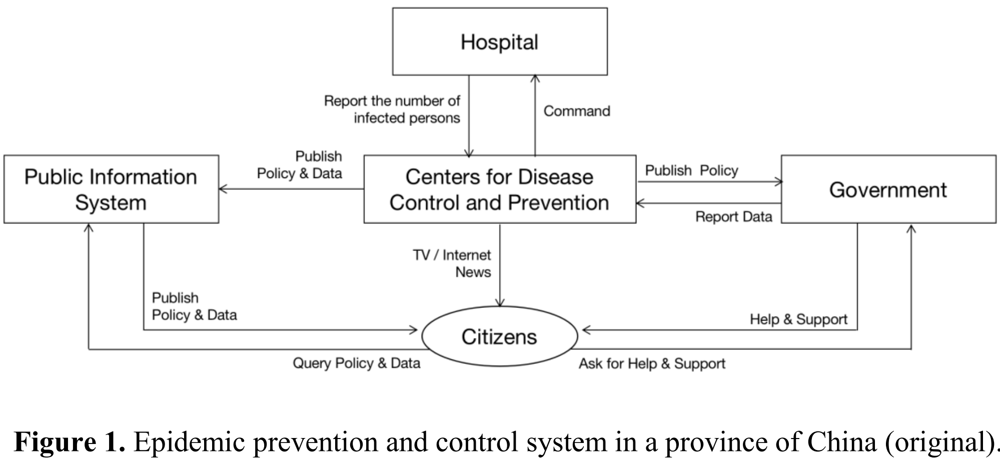

Figure 1. Epidemic prevention and control system in a province of China (original).

The government compiles and analyzes the data for the convenience of the relevant departments and then feeds it back to each smart application terminal. In this regard, academician Li Lanjuan noted, "We should apply information technology and big data monitoring tools to identify those with contact history in the epidemic area, as well as those around with contact history" [4]. For instance, a Chinese news application has introduced a "patient same-journey query function" to determine if there are any confirmed cases or hidden contacts near the user's train or airplane seat [5]. Sharing information on "emergency spread" and "search for close connections" can aid in locating all sick individuals as fast as possible, hence allowing more time for the prevention and management of an epidemic. Based on the pandemic condition in various provinces and cities, the regions were classified as high-, medium-, and low-risk locations. The residents' health QR code was developed by the Chinese government to display inhabitants' health status. If there is a non-green code situation (Green is normal and offers no risk, Yellow is a risk, and Red is a verified case), strict control mechanisms and centralized isolation will be implemented for such employees (Figure 2). Simultaneously, the police agency uses mobile phone location data, ticket information, and other methods to enquire about employee movement.

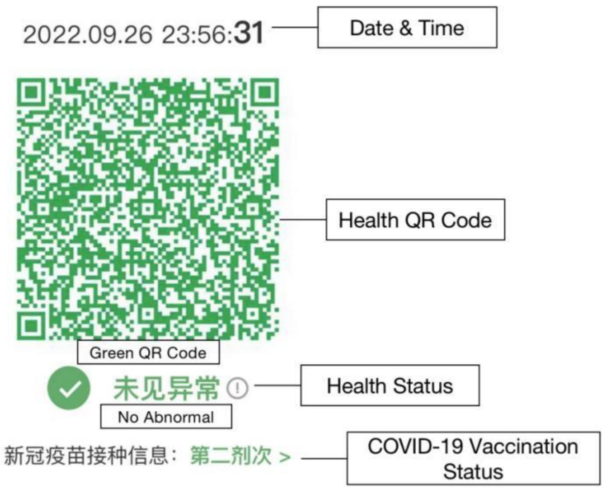

Figure 2. Health QR Code (screenshot from the author’s mobile phone).

6. Early warning mechanism based on big data technology

In the early phases of an outbreak, hospitals and pharmacies are usually the first venues where patients are visited and where danger information is communicated. By obtaining real-time drug sales data from various retail pharmacies and designated medical institutes, it is feasible to have access to previously unknown information. By analyzing the huge amount of medical data collected on a national scale, artificial intelligence systems can swiftly identify abnormal patients. Using big data to analyze national medical data in accordance with the two fundamental criteria of infectious diseases, we can swiftly establish whether infected individuals with the same symptoms have had close contact with one another over a specific time period (all infected people have the same symptoms, and generally only spread among close contacts). If it is determined that the symptoms of dispersed sick individuals who have all visited the same location within the last three days are same, the onset of the epidemic can be swiftly traced and the relevant individuals can be managed at the appropriate time.

Big data can play a big role in the containment of the epidemic if the government implements emergency measures, but the early warning system will not function properly if the outbreak comes unexpectedly and rapidly. Big data technology was used to rapidly analyze the activity trajectory of confirmed cases and close contacts by collecting the information of confirmed cases in the hospital and the information of people who had purchased fever drugs or other related drugs from pharmacies within a certain time frame after the incident. Using this information, the pandemic spread model and positioning system were developed. Based on confirmed cases, close contacts of mobile phone positioning system, with mobile phones, the physical distance between calculated within the scope of, must contact time more than other associated mobile users, combined with analysis of social relations between the two sides of infected probability, then lock a large number of close contacts, the relevant experts and government agencies. Rapid construction of a large-scale mechanism for the prevention and control of epidemics using big data. By submitting their personal information simultaneously into the government's and enterprise development's public information systems, the public was able to determine if they traveled by the same mode of transportation as confirmed cases or close contacts. You can even use the applicable platform's map to gain community information about the locations of confirmed cases and close contacts, which provides a plethora of important information for subsequent prevention.

Big data can also aid in concentrating high-quality medical resources in high-risk regions and optimizing the allocation of medical resources. For instance, China has established a national vital medical materials support platform for the Ministry of Industry and Information Technology (Figure 3), and big data is utilized to record and monitor the full process of materials from shipping to receiving and use. Through data analysis and model building, the government implemented materials and medical staff for epidemic prevention, optimised the supply and distribution of medical resources, and accomplished joint prevention and control [5]. Local governments can manage and distribute important medical supplies consistently to satisfy the needs of epidemic prevention in strategic areas, while the national government can rapidly respond to the needs of diverse regions, as indicated by the platform's data feedback.

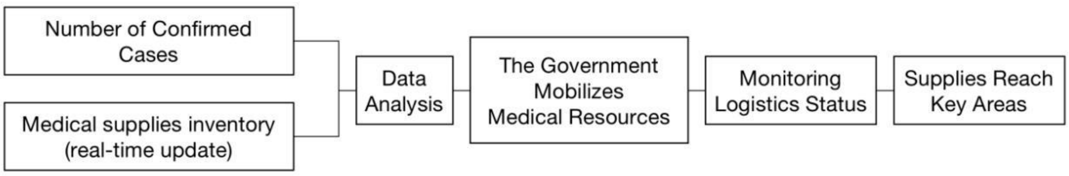

Figure 3. Flow Chart of Key Medical Material Support Platform (the public data of the Ministry of Industry and Information Technology of China).

7. Early warning mechanism based on Internet of Things information collection

The first time an epidemic breaks out, not all sick folks will visit a hospital for a diagnosis or purchase medications for epidemic prevention and control. They can travel anywhere in the United States or abroad by rail, airplane, or other significant modes of public transport. In the last stages of epidemic prevention and control, enterprises began to restore labor and production to ensure sustainable economic and social development, resulting in an unavoidable influx of individuals. Increased movement and clustering increase the likelihood of a pandemic resurgence; hence, an early warning system that can rapidly target large, ambiguous populations is required.

Using a thermal imaging cervical temperature device in public places such as airports, shopping malls, hospitals, and pharmacies enables the automatic collecting of data and the rapid diagnosis of excessive temperatures. Once the throng has dispersed and faces can be seen clearly, personnel can isolate temperature abnormalities using facial recognition and artificial intelligence technology. This big data early warning system may achieve automatic real-time early warning in densely populated public spaces, thereby considerably enhancing the effectiveness of screening. This is accomplished through the Internet of Things, which automatically collects data for analysis and diagnosis. Currently, airports and train stations in a substantial number of Chinese cities feature a "Internet of Things Plus big data" pandemic early warning system. All provinces and localities in China have deployed a specific sort of QR Code that displays the health status of its residents. Travel professionals can scan the official QR Code, register, and submit personal information by scanning and inputting the code. The system backdrop will then build an individual Health QR Code based on the results of the big data study. This QR code is based on the various danger levels that may be present in the impacted area.

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Green signifies that the individual has not entered the virus-infected area during the quarantine period, enabling interregional movement to continue. The colors Yellow and Red represent risk and proven cases, respectively.

The Chinese government mandates that the three communication operators in China fully utilize the benefits of telecom Big Data and give users with Communication Big Data Travel Cards so that users can verify the information about the provinces and cities they have visited during the past 14 days. This is in response to the tremendous return of activity and production throughout the nation as a result of the COVID-19 outbreak (Figure 4). This information can be forwarded to the relevant departments as a vital guide for my visit to the affected areas [7]. People who have not traveled through medium- and high-risk areas must adhere assiduously to local epidemic prevention regulations and methods.

Figure 4. Communication Big Data Travel Card (screenshot from mobile phone).

8. Conclusion

The significance and specialized use of big data and artificial intelligence for epidemic early warning, as well as the role and application methods of big data and artificial intelligence in epidemic prevention and control, were elucidated. Due to the conditions, relevant professional experiments are absent from this study. If future conditions are favorable for doing professional experiments, the author will conduct additional study.

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