Research on Strategies for Utilizing Big Data Technology in the Prevention and Control of Infectious Diseases and Epidemics

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Abstract: This paper reviews the application experience and existing problems of big data technology in preventing and controlling infectious diseases. Big data technology can provide strong support for the epidemiological investigation of infectious diseases and is conducive to achieving accurate prevention and control of infectious diseases and epidemics. It is suggested that the health department should establish the application thinking of big data technology as soon as possible and form the mechanism of applying big data technology in combination with the construction of digital government. In addition, pay attention to information security.

1. Introduction

Currently, big data technology is developing rapidly in various fields of society. The construction projects, such as digital government cloud platforms and government affairs, characterized by cross-department, cross-region, openness and sharing, and efficient coordination, are taking shape and deepening. Mainly since the outbreak of the epidemic in 2019, localities have applied big data technology to daily life, such as tracking the source of infection, identifying the transmission chain, and using big data to identify close contacts. People need the practical support of big data technology to comprehensively analyze and take measures to quickly curb the spread of infectious diseases. The health department should take this opportunity to actively promote the application of big data technology in preventing and treating infectious diseases so that it becomes a powerful weapon to respond accurately to major infectious diseases.

2. Problems in the Use of Big Data Technology in the Prevention and Control of Infectious Diseases

In preventing and controlling infectious diseases and epidemics, the special team for epidemic prevention and control has adopted unconventional means, such as big data technology, to respond accurately and effectively to the epidemic. However, the epidemic has entered a normal stage. For the prevention and control of infectious diseases in the future, if the health department does not get support from the "epidemic prevention and control special team," the application of big data will face a series of difficulties.

2.1 Lack of Primary Data Resources Supporting

Until now, the health department lacks support for primary data resources and cannot widely apply big data technology to epidemic prevention and control. In the process of epidemic prevention and control of infectious diseases, the "epidemic prevention and control special team" quickly collects critical information from multiple functional departments through emergency mechanisms, such as residents' travel routes, medical records in the hospital, and pharmacy purchase recordings. Moreover, experts from many sectors are organized to conduct data analysis. After the implementation of standardization, health departments often find it challenging to collect and analyze information from

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other departments because there are information barriers between departments. As a result, it is difficult to establish a primary database [1].

2.2 Lack of Thinking of Using Big Data Technology to Solve Problems

Based on the background of promoting big data technology in society, the health department needs to establish a working mechanism for applying big data technology and employ relevant technical personnel. They lack the thinking and ability to solve problems in daily work with the help of big data. For the problematic situation such as COVID-19, the new SARS epidemic, SARS or other major infectious disease epidemics, if the local government cannot urgently set up the "epidemic prevention and control special team" or similar coordination agencies to take adequate measures, it is likely to cause dissatisfaction with the treatment of the health sector.

2.3 Low Degree of Data Sharing between Regions and Departments

Local governments are actively building digital governments and are committed to promoting social governance through big data technology. However, practical applications show that the current digital government still mainly focuses on data presented to the public and lacks management in decision-making. At the same time, the data sharing problem between regions and departments still needs to be solved. A cross-regional and cross-sectoral comprehensive prevention and control system has yet to be formed, considering epidemic prevention and control.

3. The Application of Big Data in the Epidemic

3.1 Digital Epidemiological Surveillance

To respond to public health emergencies, we need to understand the location, time, and spread of infectious diseases and identify risk factors to develop effective intervention strategies. Researchers use digital information to enhance and interpret the epidemiological data of infectious diseases collected by public health institutions.

Today, the Internet has become one of the data sources for early disease detection. Population surveillance systems generally rely on health-related data, clinical diagnostic information, and symptom surveillance networks. At the same time, data from online news sites, news aggregation services, social networks, and community-engaged research enrich these databases with new information. Online data filtering systems using natural languages processing and machine learning techniques like Pro MED-mail, GPHIN, Health Map, and EIOS can integrate and summarize epidemiological information to assist epidemiological surveillance. These data sources are gradually applied to the surveillance of infectious diseases. The EPI-BRAIN platform is the primary platform for the World Health Organization to collect infectious disease data and information for emergency preparedness and response, including environmental and meteorological data. The UK uses an automated syndromic surveillance system to identify infectious diseases and epidemics, scan digital records, and aggregates national health service data [2].

To identify those susceptible to infectious disease outbreaks, the UK uses an automated syndromic surveillance system that scans the digital records of the National Health Service. However, information collection systems are subject to selection bias and overinterpreting results, and there needs to be more consistency in reported monitoring indicators.

For decision support, data visualization tools play a vital role. At present, data visualization panels are widely applied in public health data collation during the pandemic, including confirmed cases, death numbers, and the number of tests, so that the public can better understand the situation and provide support for decision-makers to develop interventions. The data visualization panels of infectious diseases and epidemics mainly focus on time series charts and geographic maps, ranging from regional-level statistical data to case-level. In addition, some data panels also represent broader responses, including clinical trials, political and economic interventions, and responses to social marginalization. Data collection quality and consistency are facing significant challenges and attracting public attention. Due to the lack of official standards, the statistical data governments' reports are inconsistent, which brings difficulties to global comparisons. Also, obtaining up-to-date and accurate offline statistics from the government takes work. Therefore, existing visualization techniques continue to be innovatively designed. For example, the Next Strain open-source storage system creates a map of viruses spreading worldwide.

3.2 Fast Identification of Suspected Patients

During a pandemic, isolating patients and close contacts are essential to reduce transmission and detect suspected patients early and quickly. Moreover, we need to recognize the principal risks and transmission patterns. Digitization technology can achieve these goals through case identification, large-range community detection based on symptoms, and active reporting to public health databases. Cases in Singapore and the UK can be obtained through online symptom reports, and only isolation advice is provided for suspected patients. In addition, they are introduced to further medical services, such as video evaluation and detection. These services can be implemented rapidly but must be linked to ongoing public health surveillance and actions, such as isolating patients and close contacts. Although the method applies to populations with symptoms, extensive population testing and contact tracing are essential in identifying suspected patients, as about 80% of infectious disease outbreaks in the population are mild or asymptomatic. In addition, the researchers studied wearable technology to monitor the spread of infectious diseases in the population.

Rapid diagnostic testing can expand its coverage and improve its detection capabilities through decentralized and digital connections, thereby alleviating the pressure on healthcare systems and diagnostic laboratories [3]. The PCR methods for rapidly detecting infectious diseases are being developed, but it is now limited to internal use in medical institutions. Although the drive-in detection facilities and automatic swab kits have expanded the detection range, there are sampling, sample delivery, sample detection, waiting for results, and follow-up delays. In contrast, families, communities, or third-party testing agencies can perform antibody tests quickly and get results within minutes. Linking patient information with large geographic areas by connecting to smartphones with automated reading capabilities powered by image processing and machine learning, enabling rapid reporting of results to clinical and public health systems for faster publication of results be converted.

3.3 Interrupt Community Transmission

After diagnosis and isolation treatment, close contacts must be tracked and isolated immediately to curb the spread of the virus. In high-risk areas, expanding the scale of these interventions and strengthening monitoring is necessary, which is a challenge for traditional methods.

Digital close contact tracing tools are necessary to avoid human memory dependence on interpersonal contacts and to track the size and speed of close contacts more efficiently in densely populated, mobile areas. During the global pandemic, the application of digital processes for contact tracking has been widely developed. The methods and technologies used by these applications have been popularized on an unprecedented scale, and privacy protection has attracted much attention. Therefore, the relevant managers need to evaluate the accuracy and effectiveness of the application.

In the past, digital tracking has raised privacy concerns. In South Korea, location, monitoring, and transaction data are used to track contacts of confirmed cases. The Alipay health code application automatically detects locations, limits high-risk user transactions, and implements strict isolation measures. Recently, governments have collaborated to publish voluntary contact tracing applications to collect locations using GPS systems or cellular networks. In addition, the surrounding information can be received through Bluetooth.

There are critical limitations to the contact tracing app, such as the need for large numbers of users and listening to advice to successfully suppress transmission. In addition, the use of applications is also limited by smartphone ownership, user trust, availability, and mobile phone compatibility. At the same time, practical problems still need to be solved, such as determining the contact person and the contact time to trigger the alarm [4].

Mobile data were used to assess epidemic prevention measures. Smartphones collect location data via GPS, cellular networks, and Wi-Fi to monitor population movements in real-time, identify potential sources of infection, and determine the effectiveness of public health responses. However, accessing mobile data presents significant challenges, and these methods raise ethical and privacy issues. Many technology and telecommunications companies have started offering privacy-protected mobile data in response to the epidemic. However, the dataset size is limited, and no long-term data-sharing promises exist. Currently, Baidu uses a daily collection of origin and destination information to assess the impact of travel restrictions and quarantine measures on the spread of infectious diseases in China. In addition, Google published its weekly regional mobility report, which provides a detailed analysis of different travel types and destinations (such as workplaces and transportation) and provides publicly available downloadable data. However, data sets are provided by various providers, there are standardization issues, and they do not cover all countries and regions.

Considering the differences in the community, family size, age groups, and contact ways, evaluating mobility and contact ways is essential. They help to further understand the impact of interventions such as hand washing, social isolation, and school suspension on slow transmission. Monitoring social distancing measures can predict health system needs and is conducive to easing restrictions. However, behaviors such as tracking, social isolation, and using wearable devices and drones involve violations of civil liberties and privacy issues, causing concerns [5].

3.4 Public Communication: Inform the Masses

Implementing interventions during the pandemic relies on public education and collaboration, underpinned by appropriate communication strategies, including active community engagement to gain public trust. Currently, 4.1 billion people use the Internet worldwide, while there are 5.2 billion mobile phone users. Targeted communication via digital platforms can help mobilize communities and achieve broad acceptance. However, significant challenges remain to overcome, such as the spread of misinformation. Public health agencies and technology companies are stepping up cooperation to curb the spread of misinformation and prioritize trusted online news sites. SOS alert interventions like Google's put WHO and other trusted sources at the top of search results on the website. According to the United Nations research, almost all member states have posted information about the epidemic on their national websites, and many countries pass information through text messages to people who cannot access the Internet. In addition, chatting robots are essential in reducing the burden of non-emergency medical consultation call centers. Especially in primary care, the rapid adoption of telemedicine services is changing clinical practice.

The digital platform supports social distance management measures, video conferences, and online services to realize many convenient functions such as home office and online classes, caring for mental health, and collaborative community mobilization. However, security risks, especially leaks of confidential medical information, are attracting public attention.

4. Conclusion

Practical experience shows that the complete application of big data technology can further improve the accuracy and effectiveness of preventing and controlling infectious diseases and epidemics, avoid wasting resources and reduce the burden at the grassroots level. The health department is the main force of epidemic prevention and control. The health department is the leading force for epidemic prevention and control. In the future, managers should actively introduce big data technology and continuously improve skills and levels by applying big data technology analysis.

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