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Strategies for the Application of Big Data in Preventive Medicine in the Field of Public Health

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Abstract: The purpose of this article is to deeply explore the application strategies of preventive medicine big data in the field of public health, with a view to improving the efficiency of public health services, promoting the health level of the population and achieving health equity. Through literature analysis and comprehensive investigation from interdisciplinary perspective, this article systematically combs the application status and challenges of preventive medicine big data in disease monitoring and early warning, health risk assessment and intervention, public health policy formulation and evaluation, and health education and promotion. From the perspectives of sociology, ethics and law, this article comprehensively discusses the social impact, ethical challenges and legal regulation of the application of big data in preventive medicine. The research shows that preventive medicine big data has great application potential in the field of public health, but it also faces many challenges such as data quality, privacy protection, insufficient interdisciplinary cooperation and ethics and law. In view of these problems, this article puts forward corresponding solutions and points out the future research direction.

Keywords: Big data; Public health; Application strategy; Social value.

1. Introduction

Today, with the acceleration of globalization, demographic changes and increasingly complex environmental factors, the public health field is facing unprecedented challenges [1]. The transformation of disease patterns, the frequent occurrence of new infectious diseases, the increasing burden of chronic diseases and the prominent health inequality all require the public health system to have stronger coping ability and higher efficiency [2]. In this context, the rapid development of big data technology provides a new opportunity for preventive medicine. By collecting and analyzing massive health-related data, big data technology can help public health workers identify health risks more accurately, predict disease trends, optimize resource allocation, and formulate more accurate intervention measures [3-4]. Therefore, it is of great significance to study the application strategy of preventive medicine big data for improving the efficiency of public health services, promoting the health level of the population and realizing health equity.

In recent years, scholars have made extensive explorations in the application of big data in preventive medicine [5]. In disease monitoring and early warning, big data technology has been used for early detection and tracking of infectious diseases such as influenza and dengue fever. In health risk assessment, the model based on big data can predict the health risk of individuals or groups more accurately [6]. In policy formulation and evaluation, big data analysis provides strong support for scientific decision-making of public health policies. However, despite remarkable progress, the application of preventive medicine big data still faces challenges such as different data quality, privacy protection problems and insufficient interdisciplinary cooperation [7]. Therefore, it is very important to systematically sort out the existing research results and summarize the successful experiences and existing problems to promote the in-depth application of preventive medicine big data. The purpose of this study is to explore the application strategy of preventive medicine big data in the field of public health.

2. The Basic Theory and Practical Framework of Big Data in Preventive Medicine

Big data refers to a large-scale, diverse and fast-processing data set, and its characteristics can be summarized as "4V": volume, Velocity, Variety and Value. In the field of public health, big data includes not only traditional medical records, but also social media data, environmental monitoring data, biosensor data and other sources [8]. The integration and analysis of these data can provide more comprehensive and in-depth information support for preventive medicine.

Preventive medicine is a branch of medicine, which aims to prevent the occurrence and development of diseases by identifying health risks and taking intervention measures [9]. Its theoretical basis includes epidemiology, statistics, health education and other disciplines. In the context of big data, the theory and practice of preventive medicine have been further enriched and developed. The application of big data technology enables preventive medicine to identify risk factors more accurately, evaluate intervention effects, and provide a basis for formulating personalized health management programs.

In order to effectively use big data to support the development of preventive medicine, it is needed to build a systematic application framework. The framework should include the following key links: first, data collection and integration, obtaining health-related data through multiple channels and ways, and cleaning, integration and standardization. Secondly, it is data analysis and mining, using statistics, machine learning and other methods to extract valuable information and patterns from massive data. Thirdly, it is the interpretation and application of the results, which translates the analysis results into understandable reports or suggestions to guide disease prevention, health management and policy formulation. Finally, it is continuous monitoring and evaluation, and the process of data collection, analysis and application is continuously optimized through the

feedback mechanism to ensure the continuous and effective application of big data in preventive medicine.

3. Application Strategies of Big Data in Preventive Medicine in The Field of Public Health

3.1. Disease monitoring and early warning system

In the field of public health, disease monitoring and early warning system is an important aspect of big data application in preventive medicine [10]. By collecting and analyzing data from medical institutions, public health departments, social media and other channels in real time, big data technology can quickly identify early signals of disease outbreaks and provide timely epidemic information for decision makers. These systems use advanced algorithms and models to mine and predict massive data, and can accurately judge the spread trend, influence range and possible high-risk areas and people. Based on these analyses, the public health department can quickly start the emergency response mechanism and take necessary preventive measures, such as strengthening vaccination, implementing isolation policy and allocating medical resources, so as to effectively control the spread of the disease and reduce the social and economic impact of the epidemic.

3.2. Health risk assessment and intervention

Big data technology also plays an important role in health risk assessment and intervention. By analyzing multi-dimensional data such as individual's living habits, genetic information and medical records, big data technology can build a personalized health risk assessment model to help individuals understand their health status and potential risks. Table 1 shows all aspects of big data technology in health risk assessment and intervention in detail, from data collection to scheme adjustment, which fully reflects the important role of big data technology in improving individual health management level and preventing potential health risks.

Table 1. Application of Big Data Technology in Health Risk Assessment and Intervention

Application Phase	Specific Content
Data Collection	Collect multi-dimensional data on individuals' lifestyle habits (such as diet, exercise), genetic information, medical records, etc.
Risk Assessment Model Building	Utilize big data technology to analyze and process the collected data, constructing personalized health risk assessment models
Understanding Health Status and Risks	Assist individuals in understanding their health status and potential risks through the risk assessment models
Intervention Measure Development	Formulate targeted intervention measures for individuals based on risk assessment results, such as providing customized health management plans
Lifestyle Adjustment Recommendations	Recommend appropriate lifestyle adjustments based on assessment results, such as improving dietary habits, increasing physical activity, etc.
Physical Examination and Screening Schedule	Arrange regular physical examinations and screenings according to individual risk profiles to detect and address health issues promptly
Monitoring Intervention Effectiveness	Continuously monitor the effectiveness of intervention measures using big data technology to ensure their efficacy and sustainability
Timely Adjustment of Plans	Adjust intervention plans in a timely manner based on monitoring results to better meet individuals' health needs

3.3. Formulation and evaluation of public health policy

Big data provides a scientific basis for the formulation and evaluation of public health policies. Through the analysis of historical data and real-time data, policy makers can more accurately understand key information such as disease burden, health demand and resource allocation, so as to formulate more reasonable and effective public health policies. In addition, big data technology can also be used to evaluate the implementation effect of policies. By comparing the data changes before and after the implementation of policies, we can judge whether the policies have achieved the expected goals, and provide a basis for the adjustment and optimization of subsequent policies.

3.4. Health education and promotion

Big data technology is also widely used in health education and promotion. By analyzing the data of people's health knowledge, attitude and behavior, big data technology can identify the key objects and contents of health education, so as to formulate more accurate and effective health education strategies. At the same time, big data can also be used to monitor the effect of health education, adjust the content and methods of education in time, and ensure the pertinence and effectiveness of health education. In addition, big data technology can also support health promotion activities, such as pushing health information through social media, mobile applications and other channels to improve public health awareness and self-care ability.

4. Challenges of Big Data Application in Preventive Medicine

4.1. Data privacy and protection

In the application of preventive medicine big data, data privacy and protection is an important challenge. Because big data involves a lot of personal sensitive information, such as medical records, genetic data, living habits, etc., once leaked or abused, it will seriously infringe on personal privacy rights. Therefore, a strict data protection mechanism must be established to ensure that data collection, storage, analysis and use meet the requirements of laws, regulations and ethical norms, as shown in Figure 1:

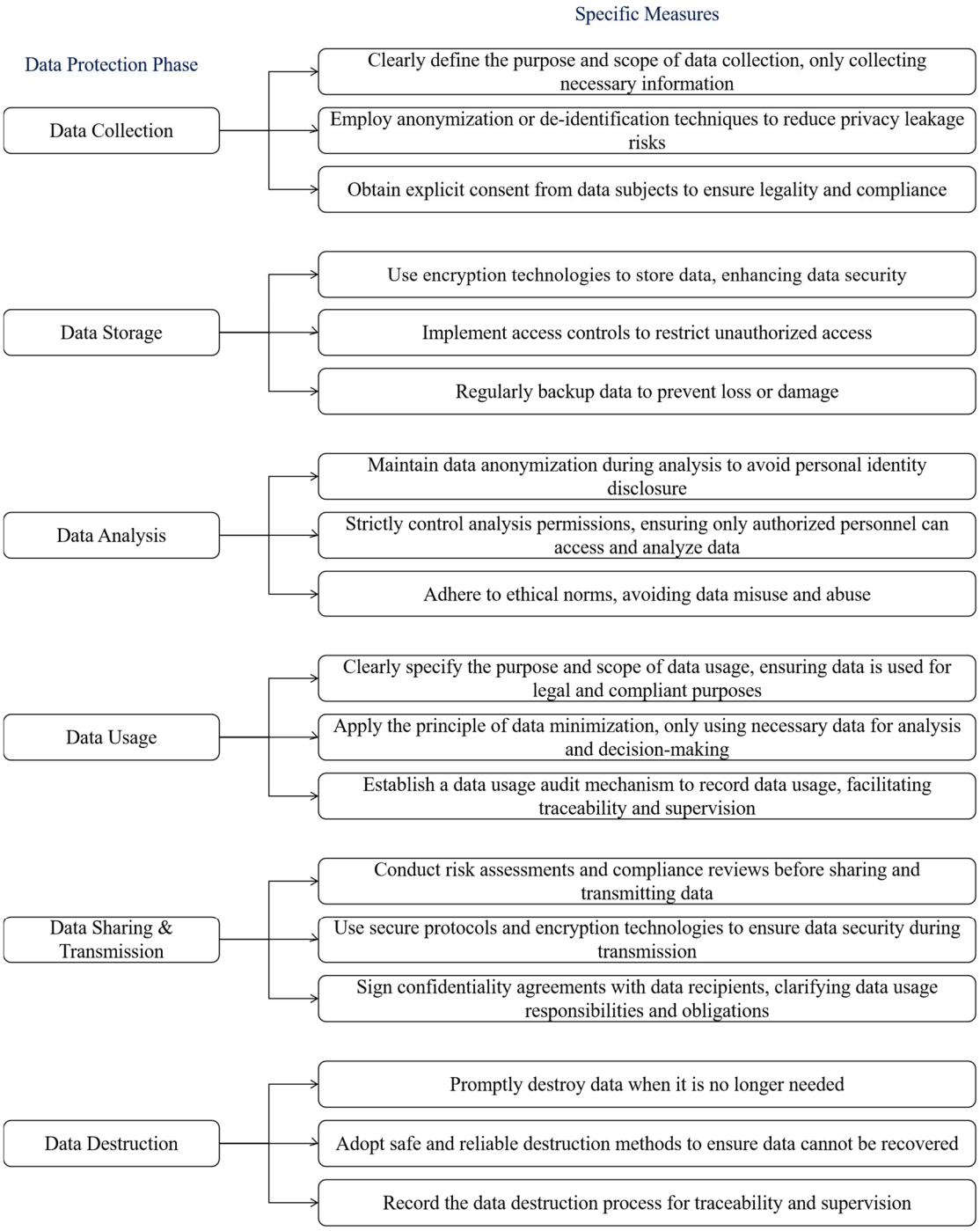

Figure 1. Data protection mechanism in preventive medicine big data application

4.2. Balance between data sharing and utilization

Data sharing is an important prerequisite to promote the application of big data in preventive medicine, but how to find a balance between data sharing and utilization is a difficult problem. On the one hand, data sharing helps to promote scientific research cooperation, improve the quality of medical services and optimize public health policies; On the other hand, excessive sharing may lead to data leakage, privacy violations and other issues. Therefore, it is needed to establish a reasonable data sharing mechanism, clarify the scope, conditions and responsibilities of data sharing, and ensure the safety and compliance of data sharing.

4.3. Ethical considerations and normative construction

The application of big data in preventive medicine also involves a series of ethical issues, such as informed consent, data bias, algorithm transparency, etc. In the process of data collection and use, it is needed to respect individuals' right to informed consent and ensure that individuals understand how their data is collected and used. At the same time, attention should be paid to the issue of data bias to avoid unfair results caused by imbalanced or biased data in algorithms. In addition, it is needed to strengthen the transparency of algorithms, so that the public can understand the working principles and decision-making processes of algorithms, and enhance their trust in big data applications.

4.4. Legal regulations and policy environment

Laws, regulations and policy environment are important factors affecting the application of big data in preventive medicine. At present, the laws and regulations on big data are not perfect, and there are problems such as unclear data ownership and unclear legal responsibility. This may lead to increased risks such as data abuse and privacy disclosure. Therefore, it is needed to strengthen the construction of laws and regulations, clarify the ownership, usage rules and legal responsibilities of data, and provide legal protection for the application of preventive medical big data. At the same time, it is needed to strengthen policy guidance and support to promote the wide application and in-depth development of big data technology in the field of public health.

5. Conclusions

The application of preventive medicine big data has important practical significance and social value. First of all, with the support of big data technology, public health departments can more accurately monitor and warn disease outbreaks, and take effective prevention and control measures in time to protect public health and safety. Secondly, the application of big data technology helps to realize personalized health management and intervention, and improve the pertinence and effectiveness of medical services. In addition, big data can also provide a scientific basis for the formulation and evaluation of public health policies, and promote the scientific and democratic policies. Finally, the application of preventive medicine big data will also help to promote health education and health promotion activities, improve public health awareness and self-care ability, and thus promote the overall health level of society. Therefore, strengthening the research and application of preventive medicine big data has important practical significance and social value.

This study deeply discusses the application strategies of preventive medicine big data in the field of public health, including disease monitoring and early warning system, health risk assessment and intervention, public health policy formulation and evaluation, and health education and promotion. Through literature analysis and comprehensive investigation from interdisciplinary perspective, this study reveals the great potential of big data technology in improving the efficiency of public health services, promoting the health level of the population and achieving health equity. At the same time, the research also points out the challenges in data privacy protection, data sharing and utilization balance, ethical considerations and the construction of laws and regulations, and puts forward corresponding solutions.

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