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Research Article

Construction and Application of Medical Economic Information System under Big Data

Xiaopeng Yu,[1] Chuanjia Yang,[2] and Jing Yang [3]

[1]*Department of Oncology, Shengjing Hospital of China Medical University, Shenyang, Liaoning 110004, China*
[2]*Department of General Surgery, Shengjing Hospital of China Medical University, Shenyang, Liaoning 110004, China*
[3]*Department of Neurology, Shengjing Hospital of China Medical University, Shenyang, Liaoning 110004, China*

Correspondence should be addressed to Jing Yang; jyang@cmu.edu.cn

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The development of medical detection, storage, and other technologies makes China's medical and health field accumulate massive data. Big data analysis technology can mine and analyze these data and establish medical information systems to enhance hospital treatment and service levels. Therefore, this work studies the construction and application of medical economic information systems. Specifically, neural networks, as a means to handle a large number of medical economic data, and has received great attention. This work uses BP neural network to extract the medical economic information feature, which is a big data technology and can extract deep features of data, after that, we compare and analyze the characteristic of different medical data. Finally, we establish the medical economic information system for the follow-up medical diagnostic services.

1. Introduction

In the past 30 years, the progress of medical and health informatization in China has gone through the stages of computerization and digitalization and is developing towards intellectualization and intelligence [1, 2]. Structured, semistructured, and unstructured medical data are stored in clinical information systems (CIS), electronic medical record information systems (EMR), radiological information management systems (RIS), medical image archiving and Communication systems (PACS), laboratory information systems (LIS), PHIS nursing Information System (NIS) Surgical, and other information systems. To improve the level of information construction data coconstruction and sharing, in the next few years, China's medical information construction will still be in a period of vigorous development, especially for electronic medical records, mobile medical, telemedicine in small and medium-sized hospitals [3]. The deployment of medical imaging and other systems will become the main growth point of the industry, and the construction of a regional population health information platform centered on patients and residents will also be carried out continuously. In addition, outpatient records should be kept for at least 15 years as required. Hospitalization records should be kept for at least 30 years. The image data is kept online for 3 years, and the data over 3 years is stored on the offline server [4, 5], more than 5 years of data archiving history server. Electronic medical record data is always online and the storage time of medical data in the Internet environment is infinite, which leads to the continuous growth of data types and sample sizes in the medical and health field [6, 7].

In addition, the detection technology, image technology, storage technology, and other technological progress. The exponential growth of data volume changes the scientific research paradigm, and big data science is gradually separated from the computer field to be an independent discipline known as the fourth paradigm [8]. With the improvement of computer capacity from GB to TB, data-driven medicine has been pushed to the forefront. As long as there are interrelated data, computers can mine them through big data analysis technology and then discover new patterns, new knowledge, and even new laws that cannot be found by traditional scientific methods in the past. China's medical field has accumulated massive data. Through mining and analyzing the value behind medical data, the diagnosis, treatment, and service level of hospitals and health service institutions will be significantly improved, and the development of the health industry will be promoted [9, 10].

The sharing of medical big data in China has made great progress, and various medical big data systems have emerged one after another. However, in general, China's medical data sharing is still at a relatively low level, and the value of medical data itself has not been fully played. How to transfer existing data into the big data system and establish a medical data platform is the development direction of medical big data and also the bottleneck encountered at present [11, 12]. Currently, theoretical studies on medical big data are mostly focused on the large data magnitude of medical big data and the value and significance of medical big data sharing. Therefore, in order to promote the landing and development of medical big data in China, it is necessary to carefully analyze the current situation of medical big data sharing in China and put forward relevant countermeasures to promote medical big data sharing to promote the release of medical data dividends [13, 14].

Modern information technology has brought about revolutionary changes in the way of human production and life. With the improvement of people's living standard, the informatization construction and level improvement of hospital medical and health care becomes more important [15]. Hospital information system refers to the comprehensive management, collection, storage, and processing of human, financial, and material information flow generated in various parts of medical institutions by means of computer software and big data technology, hardware equipment, and network technology. It is the product of the integration and penetration of computer technology and hospital information management to provide comprehensive and automatic management and service information systems for the overall operation of the hospital. In practical application, this technology can reflect the special needs of medical institutions under the unique background, and its ultimate goal is to serve republican patients [16, 17]. The medical big data feature mining and pattern discovery process are given in Figure 1.

The main structure of this paper is as follows. The second chapter gives the relevant research work, the third chapter is the main theoretical methods of this paper, the fourth chapter is the main theoretical methods of this paper, and the fifth chapter summarizes the whole paper and prospects the future work.

2. Related Work

At present, China regards medical big data as one of the important basic strategies of the country and has successively issued a number of national development plans, guidelines, and other documents. In addition, local governments at all levels have also issued medical big data related plans, such as Shanghai three-year Action Plan, Guizhou Province Big Data Industry Development and Application Planning Outline (2014–2020), Wuhan Big Data Industry Development Action Plan (2014–2018), Xiamen Big Data Application and Industrial Development Plan (2015–2020), Beijing Big Data and Cloud Computing Development Action Plan (2016–2020), Guangdong Big Data Development Plan (2016–2020) [18].

In the early 1960s, the United States began to explore the hospital information system. In the 1970s and 1980s, university teaching hospitals and medical centers successively developed hospital information systems. In 2004, the United States government enacted special legislation [19]. With the progress of technology, in order to make the patients better medical treatment enjoy a broader range of high quality medical service, telemedicine information system has become a mainstream research direction. In addition, the United States encourages standardization construction, supplemented by perfecting the laws and regulations support, the government and nongovernmental organizations established technical standard, so that medical institutions, including hospitals, drug bureaus and civil insurance companies, can connect information and share data [20]. Almost at the same time as the United States, computer technology has entered the financial management of Japanese hospitals, equipment management, emergency treatment, and other fields. At the end of the 1970s, some big hospitals began to study the establishment of hospital information systems. In the 1980s, the construction of HIS in Japanese hospitals began to popularize, and its rapid development and large scale are the mainframe as the center of the hospital computer system [21]. The hospital informatization construction in China started late, 20 years behind western developed countries. It developed along with computer and network technology and began in the late 1970s and early 1980s. The relatively complete hospital information system, which is mainly applied in the charge management of hospitals, was established in the early 1990s. From the development of medical information systems in developed capitalist countries, it is the development process of various standards related to medical activities. The United States has established and gradually improved many famous standards in the development of hospital information systems. In the process of the construction and development of HIS in China, the standards and regulations formulated by relevant national departments are relatively backward, which is a major obstacle to the construction of HIS in China [22].

Under the favorable background of national policies, various regional health and medical big data centers, health big data industrial parks/bases/laboratories have been established in various places, and their applications involve health management, chronic disease services, convenience, and benefit to the people, public health, medical collaboration, industry governance, pharmaceutical research and development, and other new formats [23]. In addition, major scientific research institutes/centers are paying more and more attention to large population cohorts and special disease cohorts (including cardiovascular diseases, cerebrovascular diseases, respiratory diseases, metabolic diseases, rare diseases, etc.). The above projects generally involve distributed transmission, aggregation, storage,

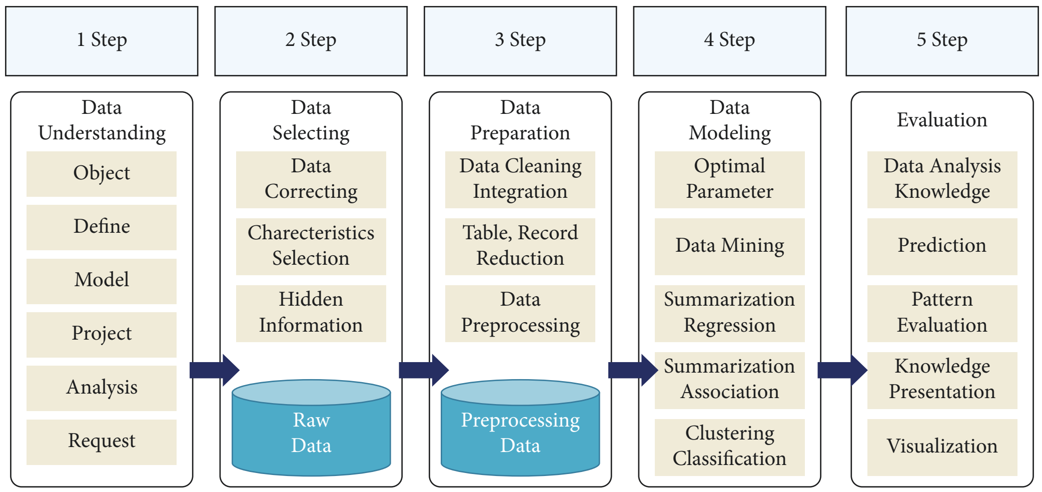

Figure 1: Medical big data feature mining and pattern discovery process.

analysis, and utilization of clinical and diagnostic data of patients [24]. On the one hand, data is required to flow truly and reliably among users and research institutions. On the other hand, data privacy protection, desensitization and encryption are very common in everyday life, and a complete and credible cooperative operation mechanism is also required [25, 26]. The input and output of supporting work, such as data security and trust, are obviously outweighed by the medical progress brought by scientific research work itself. The promotion of blockchain technology provides a powerful means to solve the above problems in the field of health and medical treatment.

Generally speaking, hospital informatization in China has the following development trends:

(1) Digital hospital management financial charges, drugs, and equipment management are only a small part of the hospital information system, which is only partial informatization. "Patient-centered" is the concept advocated by digital hospital management, which requires the use of modern management methods and means to integrate information. Hospital information system can well meet these needs.

(2) In this process, it is necessary to unify protocols and standards to make data flow and information flow smoothly in the hospital system, achieve a paperless, film-free, and documentless system, promote equal information sharing, enhance the fairness and justice of medical services, and improve transparency.

(3) Electronic medical records and telemedicine are possible. Electronic medical records not only include static information but also include various related services. Its characteristics of large capacity, good sharing, permanent storage, ease to use, and long-distance transmission enable it to be well applied in telemedicine. Throughout the world, the construction of hospital informatization has begun to start with telemedicine services, focusing on patient safety, clinical management decision support, and evidence-based clinical practice. Combined with the now widely popular big data analysis and artificial intelligence algorithm, the construction of medical informatization has reached a new height. In order to realize big data analysis, it is essential to collect patients' information in a comprehensive and three-dimensional way [27]. The establishment of an information collection platform with wide coverage and a large amount of data provides data support for the construction of an intelligent medical system. It is necessary to achieve three-dimensional, full scope, and full coverage as far as possible to avoid omission, leaving no dead spots [28, 29].

Additional optional parameters include invasive blood pressure, end-respiratory carbon dioxide, respiratory mechanics, anesthetic gas, cardiac output (invasive and non-invasive), EEG bifocal index, and so on. The medical monitoring system still remains in a separate level, resulting in the inability to establish a unified platform and transmission channel and centralized data collected by various devices [30]. Although the data transmission standard provides theoretical support in data transmission protocol, it lacks the data support of equipment in concrete implementation. On the other hand, the inconsistency of the communication interface also causes the poor portability of the system, and the phenomenon of "information island" exists in the vertically constructed system, resulting in an increase of cost and excessive development. All kinds of hardware devices that are not interconnected cannot serve users (medical personnel and patients) centrally and hierarchically, resulting in blank or redundancy of monitoring indicators. Therefore, there is still a long way to go in the informatization, standardization, and platformization of monitoring system data [31]. Compared with PACS, RIS, LIS, and other important components of hospital information systems, CIS has scattered data, resulting in a data vacuum of the most direct and subtle physiological parameters for patients. In order to realize the interconnection of monitor data, the main difficulty lies in the lack of a unified data interface and mutual confidentiality of communication protocols of numerous monitor brands, which makes it difficult to integrate real-time monitoring data [32]. Therefore, in the stage of large-scale medical data acquisition, a highly compatible interface model is needed, in the stage of transmission and reception, a universal transmission protocol is needed, and in the stage of storage, hardware equipment with large memory and better confidentiality character is needed.

3. Construction and Application of Medical Economic Information under Big Data

3.1. The Big Data Era. There is no unified opinion in the academic circle, which usually refers to the data set that cannot be captured, managed, and processed within a certain period of time by using conventional software tools. Big data generally has five characteristics, including large scale, high speed, diversity, rich value, and authenticity scale.

A certain data scale is a basis for big data to play its role. High speed means that large-scale data determines the high speed of data acquisition. Diversity refers to the variety of data types and wide source channels; Value refers to the use of big data that can create high value at low cost [33, 34]. At present, the application of big data has been attached great importance by governments all over the world. Various types of large databases of local governments in China are gradually being built, and government information is also one of the important aspects in the application field of big data [35]. The medical economic information system is also one of the important aspects of big data applications [36]. A large amount of medical economic data are brought, so the conventional medical economic information system construction methods will be ineffective or even ineffective, so it is urgent to study the new methods, and neural network is a typical representative.

3.2. BP Neural Networks for Medical Economic Information System Construction. BP (Back Propagation) neural network is a network structure connected by various independent units. By simulating the neural function of the human brain, the data samples are learned and the link weights and thresholds between units are established to deal with complex nonlinear problems without specific functional forms. According to the error between the actual value and the expected value, from the output layer through the hidden layer to the input layer, the link weight between each layer is revised layer by layer, which is shown in Figure 2.

Through repeated weight modification, the difference between the actual value and the expected value is gradually reduced. When the error is less than a certain value, it indicates that the network training is completed.

$$E = \sum_{i=1}^{m} (x_i - c_i)^2. \tag{1}$$

Then, expand the above error definition to the hidden layer:

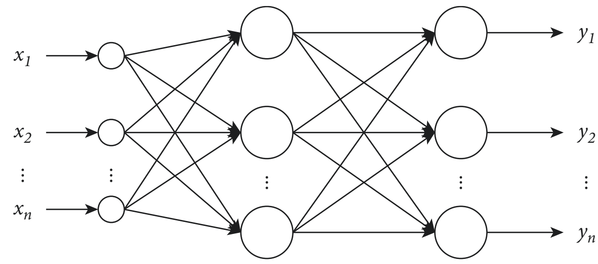

Figure 2: Schematic diagram of BP neural network.

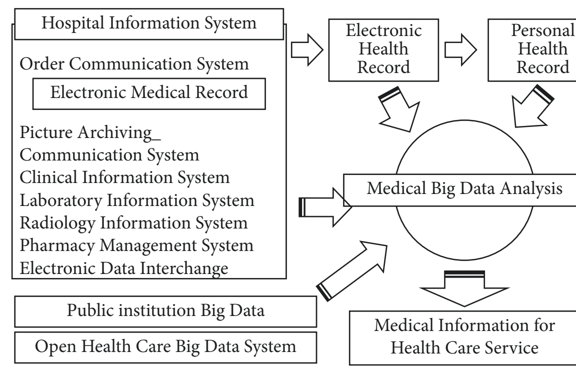

Figure 3: Medical economic information system construction based on BP network.

$$\begin{aligned} E &= \frac{1}{2}\sum_{\kappa=1}^{\ell} \left[d_\kappa - f(\mathrm{net}_\kappa)\right]^2 \\ &= \frac{1}{2}\sum_{\kappa=1}^{\ell} \left[d_\kappa - f\left(\sum_{j=0}^{m} \omega_{j\kappa} y_j\right)\right]^2. \end{aligned} \tag{2}$$

Expanding further to the input layer, there is the following:

$$\begin{aligned} E &= \frac{1}{2}\sum_{\kappa=1}^{\ell} d_\kappa - f\left[\sum_{j=0}^{m} \omega_{j\kappa} f\left(\mathrm{net}_j\right)\right] \\ &= \frac{1}{2}\sum_{\kappa=1}^{\ell} d_\kappa - f\left[\sum_{j=0}^{m} \omega_{j\kappa} f\left(\sum_{j=0}^{n} v_{ij}\chi_i\right)\right]^2, \end{aligned} \tag{3}$$

$$\Delta\omega_{j\kappa} = -\eta \frac{\partial E}{\partial \omega_{j\kappa}}, \quad j = 0, 1, 2, \ldots, m; \quad \kappa = 1, 2, \ldots, \ell, \tag{4}$$

$$\Delta v_{ij} = -\eta \frac{\partial E\, \partial}{v_{ij}} \quad i = 0, 1, 2, \ldots, n; \quad j = 1, 2, \ldots, m. \tag{5}$$

Then the weight adjustment formula of each layer is as follows:

$$\begin{aligned} \Delta\omega_{j\kappa}^{h+1} &= \eta \delta_{h+1}^{\kappa} y_j^h \\ &= \eta (d_\kappa - o_\kappa) o_\kappa. \end{aligned} \tag{6}$$

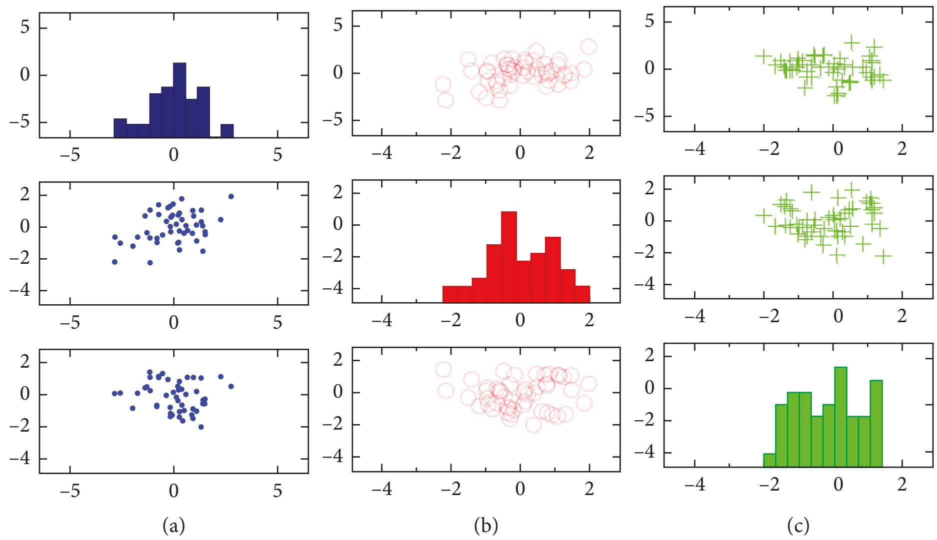

Figure 4: Age, height, and weight statistics of the subjects studied. (a) Age distribution. (b) Height distribution. (c) Body weight distribution.

According to the above rule layer by layer analogy, the weight adjustment formula of the first hidden layer is as follows:

$$\Delta\omega_{pq}^{1} = \eta\delta_q^1 \chi_p = \eta\left(\sum_{r=1}^{m_2}\delta_r^2\omega_{qr}^2\right)y_q^1. \tag{7}$$

The optimization algorithm is usually introduced to improve it. A proposed optimization algorithm for the traditional BP neural network, in the whole calculation process, generally exists in the local extremely small convergence speed and sometimes even oscillation and divergence problems to overcome the limitations in the traditional BP neural network. The differential evolution algorithm (DE) is introduced into the neural network, which can make the neural network have better nonlinear mapping ability and improve its prediction accuracy:

$$x_{i,1} = x_i^L + \mathrm{rand}\left(x_i^U - x_i^L\right), \quad i = 1, 2, \ldots, NP. \tag{8}$$

The mutation operation formula is as follows:

$$v_{i,G+1} = x_{r1,G} + F\left(x_{r2,G} - x_{r3,G}\right). \tag{9}$$

Then the interlace operation is as follows:

$$u_{ji,G+1} = \begin{cases} v_{ji,G+1} & r_j \le CR \text{ or } j = \mathrm{rand}(i), \\ x_{ji,G} & r_j \ge CR \text{ or } j \ne \mathrm{rand}(i). \end{cases} \tag{10}$$

Accordingly, the selection operations are as follows:

$$x_{i,G+1} = \begin{cases} u_{i,G+1}, & f\left(u_{i,G+1}\right) \le f\left(x_{i,G}\right), \\ x_{i,G}, & f\left(u_{i,G+1}\right) > f\left(x_{i,G}\right). \end{cases} \tag{11}$$

The fitness function is as follows:

$$f(X) = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(Y_i^0 - Y_i\right)^2}. \tag{12}$$

Based on equations (1)–(12), Figure 3 gives medical economic information system construction based on the BP network proposed in this paper. As a kind of big data technology, BP neural network is not clearly identified here but is replaced by big data technology in the figure.

4. Experimental Results and Analysis

4.1. Experimental Results' Analysis. First, the users' research data are fed into the established system and conduct statistical analysis on age, height, and weight information. The specific visualization results are shown in Figure 4. Each dot represents the relevant information of a person, and the more densely dotted places represent the more. It can be seen from the figure that the age, height, and weight of objects in the data selected in this paper are evenly distributed, thus proving the feasibility of the data and conforming to the real situation.

The user clicks the "disease information analysis" button in the system, and the interface displays information such as "year" and "disease type." Users can then click on the information they want according to their own needs. The system then sends the application program that calculates the disease drug association job to Spark platform. It calculates the parameter values required to draw the "disease information of each town" map on this platform and stores the calculated data in My Sql database. Finally, the required data is formatted and sent to the browser in JSON format. Through data analysis, the front end displays the trend chart of the number of people and disease types in corresponding years on the display interface. A visual result for disease information in the data area is shown in Figure 5.

Based on the completion of monitoring data acquisition, encapsulation, and transmission in the early stage, the data table is extended and designed to achieve the purpose of integrating monitoring data into the hospital information system and realizing the data storage process. When the number of topics above exceeds the range of observation by 0.25% to 0.50%, it needs to be reduced. There is a trade-off

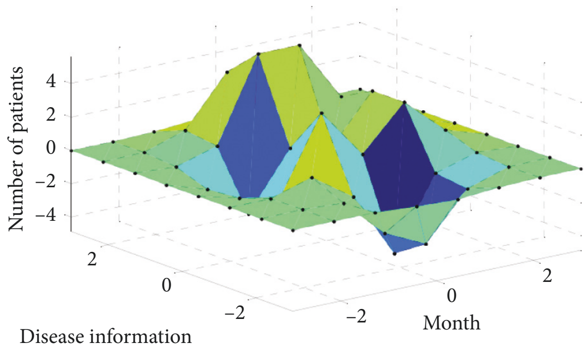

Figure 5: Visualization results of disease information data in the database.

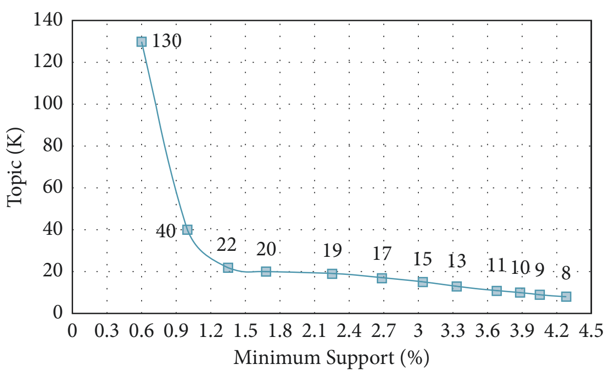

Figure 6: Minimum support is directly related to theme elements.

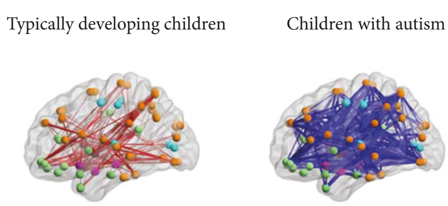

Figure 7: The difference between the typical brain and the autistic brain.

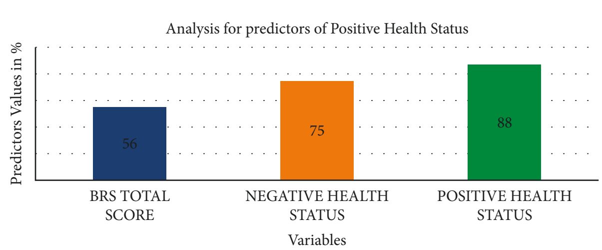

Figure 8: Analysis of psychological state results.

between the hospital and the medical staff so that it can be determined according to the needs of specific medical staff. Figure 6 shows the lowest number of topics.

The system architecture is designed to maximize the performance of server hardware, configure cost-effective data disaster recovery backup, make full use of multilevel cache load balancing and other technical means, and effectively ensure that the whole cluster runs healthy for a long time without crashes and downtime, and the system performance is stable and reliable. We can also see from our system that the brains of autistic children have more connections than those of typically developing children, as shown in Figure 7. Thus, the distinction and connection between health and pathological states can be better distinguished.

According to the results of the correlation analysis in Figure 8, we can know that this display status and positive mental health status will ultimately help medical staff determine the health level and health status of patients.

5. Conclusions

This paper firstly combs the definition, characteristics, and classification of medical big data. On this basis, the meaning of medical information systems, processes, and the significance of medical big data sharing are analyzed. Through the analysis of the problems of medical big data sharing in China, it can be seen that the key issues of medical big data sharing are profit distribution, privacy security, and standardization. Uneven data quality is the source of the problem; Uncertainties in the scope and use of shared data, lack of talent related to medical big data, big data storage, and technical problems are all reasons hindering the establishment of medical information systems. Therefore, to develop medical big data sharing in China, multipronged efforts should be made to give full play to the unity and joint efforts of all parties.

Although this paper has made a comprehensive survey on the key problems existing in the process of building medical information systems from the perspective of medical big data, there are still some deficiencies and limitations. Future research can be expanded from the following aspects: (1) Based on the current medical big data platform construction, more detailed problems and causes of sharing barriers are obtained through field research. (2) Based on literature research, the content analysis method, the problems of medical big data sharing are studied, and the subjects and technologies of medical big data sharing are studied in depth. In the future, the key problems of the medical system can be further expanded from the data itself.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

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