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Research on Key Technologies of Health Big Data Information Sharing for Chronic Patients

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Abstract: Background: With the improvement of people's living conditions and the intensification of the aging level, chronic diseases such as hypertension and diabetes are constantly troubling human health. Chronic diseases have become the biggest problem for elderly patients, and there are many problems in the sharing of health information in the self-management of chronic diseases. Objective: To find a promising and practical way to share health information of chronic disease cloud, solve the problem of chronic disease health information sharing, so as to promote the long-term treatment of chronic disease, improve the quality of life of patients, protect the privacy of patients, and realize the common benefits of doctors, patients, medical institutions and medical research institutions. Methods: A patient-centered hybrid cloud health information sharing platform was proposed. The hybrid cloud technology was used to realize the sharing of chronic disease health information among doctors, patients, medical institutions and medical research institutions, and a prototype system was realized. Results: The scheme and its prototype system realized the recording and privacy sharing of health data by using hybrid cloud, and solved many problems of health information sharing in chronic disease self-management. Conclusion: Through system verification, the proposed hybrid cloud-based health information sharing method for chronic patients will greatly improve the utilization rate of information resources, and may change the current medical service model facing many challenges.

Keywords: Chronic Diseases, Health Big Data, Hybrid Cloud

1. Introduction

With the continuous improvement of human living standards, the degree of attention to health also increases. Due to the vast area of our country and unbalanced economic development, the gap between the east and west, central city and small city, rural and urban is obvious, and the gap between medical resources is also very obvious, which brings the tension of high-quality medical resources, and it is difficult and expensive to see a doctor. [1] Doctor-patient conflict has become a normal phenomenon.

It is an undeniable fact that China's aging society is coming. In fact, chronic diseases will become a major challenge to human health. The latest statistics in 2021 have shown that the number of chronic diseases is increasing year by year, [2] and the age of patients tends to be younger. The increase of patients with chronic diseases has strained the already overburdened medical resources. Based on the particularity of chronic diseases, it is recognized that the most effective means of chronic disease treatment are screening of high-risk groups, [3]lifestyle intervention, regular follow up and monitoring. As a result of the current traditional intervention and treatment, a large number of high-risk groups miss screening, medical resources are more strained and wasted, the economic cost and time cost of patients are greatly increased, and the quality of life is sharply decreased.

In recent years, with the rapid development of Internet of things, big data and cloud storage technology, telemedicine, computer-aided decision making, precision medicine and other related technologies have become new hopes for solving current medical problems. [4] The Internet-based Home Hleath chronic disease medical treatment has

gradually become a consensus, [5] Many physiological signs of patients with chronic diseases can be recorded and shared by individuals in their living environment to specific medical service providers, which greatly improves the efficiency of chronic disease medical treatment. [6] And ensuring good long-term monitoring and care for people with chronic diseases. For example, patients with hypertension can record and upload physiological information such as blood pressure in each period through the corresponding sensors, and send these health data to various medical institutions. Expert systems or doctors can provide some clinical advice to patients based on the health data [7].

The patient's health information is very sensitive. It not only contains personal information, but also contains details of the complete medical history, symptoms, related treatments, and even family health history. When users' sensitive health data is uploaded and shared, this will bring many new technical challenges to data security and access control. At the same time, privacy and security threats may not only come from the use of data information, and specific doctors certainly have the right to access health information, including personal information. However, the involvement of third-party research institutions poses a more complicated problem, and patients certainly do not want their personal information to be shared with other unauthorized people or organizations. Obviously, the choice of health information sharing mechanism should follow patient wishes and relevant regulations or policies, not just the usefulness of health information. [8, 9]

With the popularization of the Internet, network security has become the biggest threat to the development of Internet information technology, and the loss caused by network security is tens of billions of dollars every year. In recent years, security issues such as fraud caused by personal information leakage have become the focus of public attention. It has also become the biggest obstacle to the Internet + medical treatment.

In recent years, the development of the Internet of Things has exceeded people's expectations. The emergence of various wearable devices makes it possible to transmit health information in real time. [10] However, because there is no unified standard for the security of the Internet of Things, users are more concerned about data security. Due to the particularity of personal health information mentioned above, patients are worried about the security of personal information, which leads to too little and dirty data sharing of personal health information. Of course, the processing results based on these unreal data returns will be inaccurate and useless. Obviously, the security of transmission, storage and sharing of personal health big data of patients with chronic diseases has become a key factor for the effectiveness of chronic disease management and treatment based on Internet and Internet of things. If the security of personal health information cannot be solved, it will directly affect the landing of remote monitoring of chronic diseases, telemedicine and other technologies, and the Internet and Internet of things + medical treatment will become a flower in water. [11]

At present, chronic diseases are developing towards the young age and the population is expanding. It is urgent to explore a new way of chronic disease management and treatment based on the Internet and the new technology of the Internet of things. Therefore, the research on the secure transmission, storage and privacy sharing service technology of personal health information based on the self management needs of chronic diseases has become the most critical issue of Internet + healthcare for chronic diseases. This study is to propose a universal mechanism for the secure transmission, storage, and sharing of personal health information files, which can promote the long-term monitoring and treatment of chronic diseases, so that patients with chronic diseases can have an independent and high-quality life and receive additional benefits.

2. Several Deployment Models for Health Data

The development of transmission and storage technology of personal health information depends on the development of Internet technology, Internet technology and storage technology. With the development of information technology and Internet technology, researchers around the world have put forward different solutions for the transmission, storage and sharing of personal information of patients with chronic diseases. In summary, there are the following schemes.

(1) client-server structure

The client-server structure is also called the Client/Server structure. The Server usually uses a high performance PC, workstation or minicombage, and uses a large database system, such as ORACLE, SYBASE, InfORMix or SQL Server. The client needs to install special client software. Its advantage is that it can make full use of the advantages of both hardware environment, the task is reasonably distributed to the Client and Server side to achieve, reduce the communication overhead of the system. However, its disadvantages are also obvious. Due to the characteristics of data distribution in the client-server structure, fires, robberies, earthquakes, viruses, hackers, etc. occur in the client side have become terrible data killers.[12] In addition, the data security of each node affects the data security of the whole application. With the sharp increase of access at the terminal of patients with chronic diseases, this data storage mode has been overwhelmed.

(2) Browse-server mode

Browser-server structure is a network structure mode after the rise of the WEB. Its advantage is that the WEB Browser is the most important application software of the client side. This mode unifies the client side, [13] centralizes all data parts on the server, and simplifies the development, maintenance and use of the system. The client only needs to interact with the database through a browser. Its disadvantage is that it is not satisfactory across browsers. In terms of speed and security, it needs to spend a huge design cost, and the data transmission security is not guaranteed.

(3) Public cloud

Public cloud usually refers to the cloud provided by a third party provider for users to use. Public cloud can generally be used through the Internet, and all data are processed in the cloud, which may be free or low-cost. There are many instances of this cloud, and services are available throughout today's open public network. The downside is that data security is held by a third party, so security is not controllable. [14]

(4) Private cloud

A private cloud can be built by the company's own IT organization or by a cloud provider. In this "managed private" model, a cloud computing provider can install, configure, [15] and operate the infrastructure to support a dedicated cloud within a hospital or research institution. This model gives a hospital or research institution a very high level of control over the use of cloud resources, along with the expertise needed to set up and operate the environment. The downside is the high cost of construction.

At present, medical institutions at home and abroad basically adopt (1) or (2) scheme to store related health data. These two architectures have great insecurity for data, and the consequences will be unimaginable once patient information is leaked and data corruption occurs. Therefore, each medical system basically adopts local area network operation. In addition, these two architectures make the data interoperability between the systems poor, the redundancy is small, when the amount of data reaches a certain degree, the system will be overwhelmed. Although the public cloud storage architecture has great advantages in data redundancy, security has become the biggest uncontrollable factor.

Because of the shortcomings of the traditional storage and transmission methods mentioned above, there have been some researches on the application of public cloud storage in the field of electronic health care for chronic diseases at home and abroad in recent years, such as clinical decision support system, which uses sensors to collect various information, including personal health information, social media information, clinical knowledge base, and medical expertise. The cloud architecture is used to generate standard medical information for patients. The disadvantages of such systems are lack of some important information related to patients' daily life and lack of real-time performance. The use of private cloud storage data has better control in data security, but its disadvantage of high cost cannot be ignored, because the number of patients with chronic diseases is large, which is a large expenditure for the deployment of private cloud. Moreover, not all the information of patients with chronic diseases needs such high security, so it is quite uneconomical to use private cloud storage.

With the development of cloud storage technology, the storage and sharing of both economy and security has become a trend, and the personal health information of patients with chronic diseases is divided and stored according to certain standards. The storage mode that pays attention to both security and economy has become the development trend of personal health information storage. Hybrid cloud is the solution to the above problems.

3. Realization of Health Big Data Sharing for Chronic Patients

Health big data sharing for chronic patients realizes data sharing among patients, medical institutions and medical research institutions, and its overall structure is shown in Figure 1. Patients self-manage and record health information at home, and patients can choose to share these information with specific hospitals and private clouds. These health records are stored in a specific container of the private cloud, and doctors need to be authorized to access this file. At the same time, doctors can send medical orders to patients based on relevant health information. Storing key information in the private cloud solves the security problem of health information storage.

For the public cloud, the public cloud infrastructure is used to store the patient's health records, and these information will be stored in specific buckets. The public cloud platform has the ability to provide data services to third-party research institutions, which will facilitate the collection of health data and provide data support for third-party research institutions. To solve the economic problem of health data storage, some health information will be stored in the public cloud.

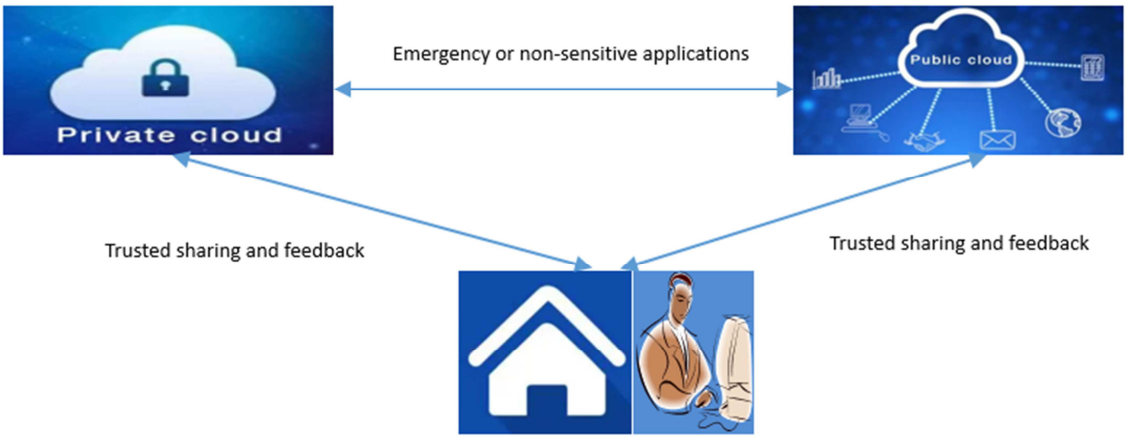

Figure 1. *Overall structure.*

4. Realization of Health Big Data Sharing for Chronic Patients

The realization of health big data sharing for chronic patients is actually that patients upload their health big data to the corresponding cloud on demand, and the cloud will store, exchange and process the data, and then share the data with doctors, medical institutions and medical research institutions according to the patients' wishes. Its structure is shown in Figure 2 below.

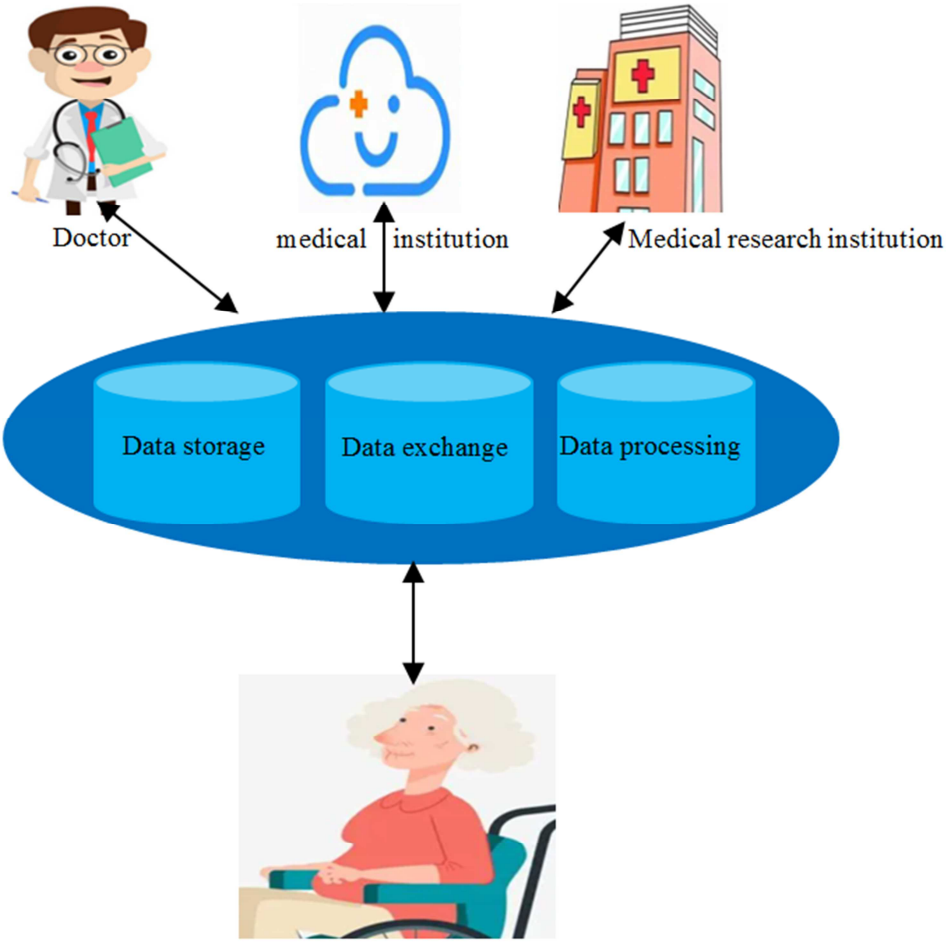

Figure 2. *Conceptual architecture of health information sharing.*

(1) Hybrid cloud deployment

This study uses Open Stack cloud platform deployment. For rapid deployment and development, Ubuntu is used as the server, and the cloud platform is installed using single-node allinone, and containers are configured. At the same time, Swift was manually configured. The specific implementation principle is as follows: In the private cloud, the health files shared by patients are stored as objects in a Swift specified data container in Opentack. These data are then entered into a cloud-based database. Physicians with physician-patient relationships will have access to health records that are shared in the data container if authorized by the owner of those data. Other doctors or nurses in partnerships can access part or all of the health records through the physician-patient relationship with the patient's consent. The system obtains the health file by tracking a globally unique tracking ID and then returns the required data.

Public cloud part: The public cloud uses Amazon Cloud computing for storage and sharing. The public cloud platform will store patients' authorized health records, and the platform can provide Iaas (infrastructure) and Paas (platform) services to third parties, while third parties can provide corresponding services to patients through the Saas of the platform. At the same time, the private cloud can expand the insensitive data storage and migrate these data to the public cloud platform. In order to provide more services to the third party of patients.

(2) health record design

Chronic patients are mainly divided into personal health data, medical health data, and third-party health data.

Health records should be designed with the following features: Segmented data and unique ids are interoperable carriers, in which segmented data of health records are designed as follows:

Table 1. *Data design.*

Personal Information	Personal Information, ID	Private could
Health status	Other illnesses associated with it	
Physical signs	Blood pressure...	
Signs	Height weight, etc.	
Family History	...	Patient narrative element records
Non-physical signs patient description	Emotions, pain, etc	
Record of life	Diet, physical activity	
Other	Other descriptions other than those described above	
Doctor description	The transcripts of the doctor's notes	Information record element
Third party description	Text formed by a third party agency	Information record element

The records of each of the above segments can be selected or selected at the patient's wish. This format serves as the standard for public and private cloud exchanges.

(3) Health record data structure design

The data structure design is based on CCD XML (Continuous Snapshot Health XML) to define electronic file metadata. The XML structure is as follows

< tag >
Properties
</ tag >

Thus the definition in A is represented by XML as follows

< Patient Records >
< Personal Information >
<id>
</id>
<name>
</name>
</ Personal information >
< Health status >
</ Health status >
...
</ Patient record >

As can be seen from the above, after XML, each relevant record forms an attribute, and the attribute value is expressed in the following table:

(4) Implementation of electronic health record engine module

In order to ensure the interoperability of information and the selectivity of shared information, it is necessary to develop the basic functions that specify these functions. The engine module is developed based on dom4j, and each record is instantiated into a class (EmrRecord).

First instantiate an object (document) for each field, Define the document member variables (below), which are basically basic information.

ClinicalDocument
RecordTarget
Component
StructuredBody
……
ComponentA
ComponentB
ComponentC
ComponentB
Section
……
title
Private document name
Private document generalHealth
Private document familyHistory
...

When a New instance is created, the class object in dom4 uses SAXReader to read the corresponding XML data. These data will be initialized into the corresponding document object, and the initialization process is a parsing process, which is a recursive algorithm pseudocode as follows:

```
Walk(item,name)
Do while size<item.nodeCount()
    For i=0, i<size, I ++
        If node instaceof item and name==node.name
            Then ximlString<node.asXML()
        Else if node instanceof itme and
name!=node.name
                Walk(node,name)
```

There will also be some other related functions, such as hide related information function, select share function, data segment function, send data function, share function, field concatenation function, etc.

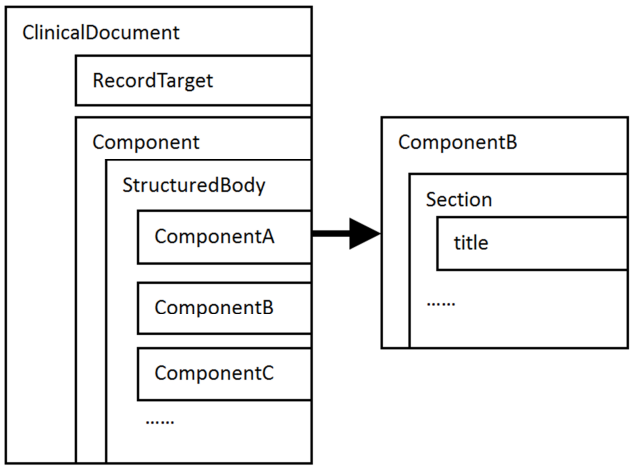

Figure 3. *Expression of attribute values.*

5. Validation

First of all, patients with chronic diseases log into the system and enter the interface in Figure 1, which contains

some categories of electronic health records. Patients can input their measured health data into the corresponding form, and then share it with the corresponding institutions or doctors according to their own will.

After confirming that the shared information is correct, the health information data will be uploaded to a container in the private cloud. As mentioned above, this container is a global ID of the patient, and these contents are the file names of the health records uploaded to Swift. In addition, health records shared to the private cloud are complete and non-anonymous, but those shared to the public cloud or a third party are anonymous.

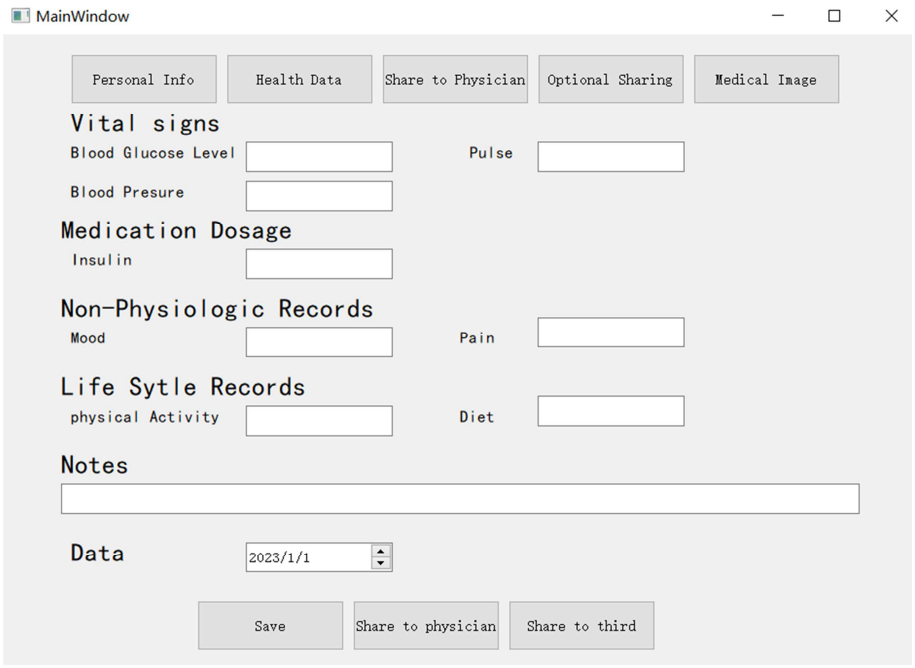

Figure 4. *Interface for health data recording and sharing.*

When patients share the corresponding health data, doctors or third-party institutions can view the corresponding data and make corresponding processing based on these health data, as shown in Figure 4.

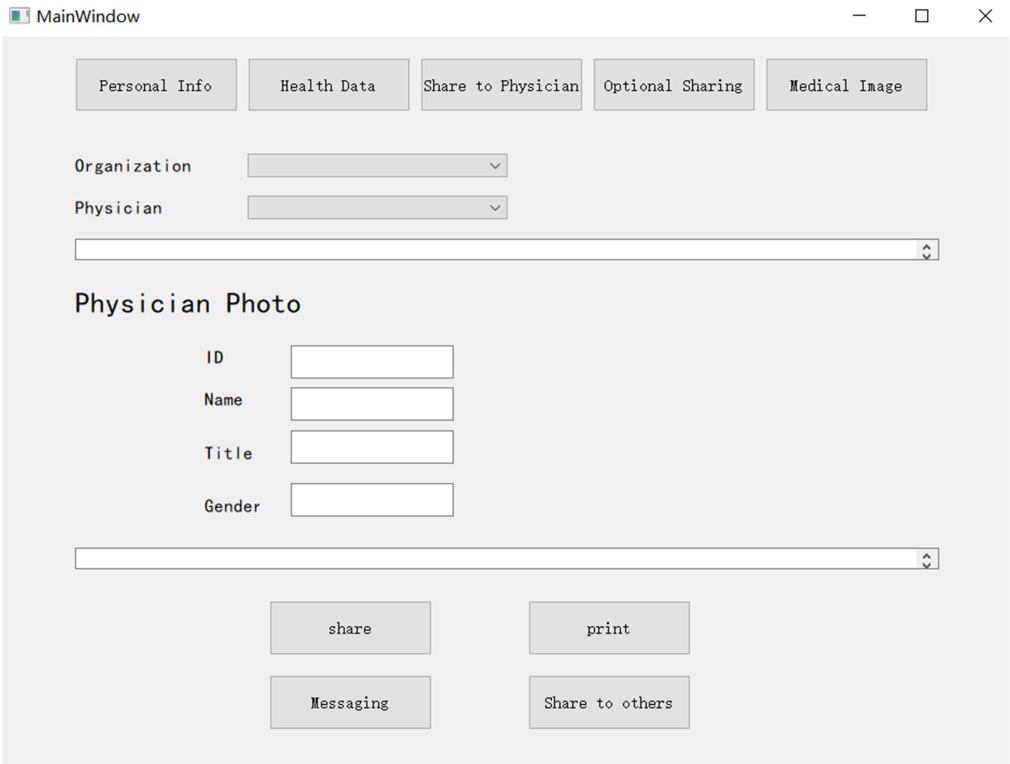

Figure 5. *Doctors get the sharing interface.*

6. Conclusion

This paper analyzed four cloud computing deployment models and proposed hybrid cloud to deploy chronic disease health information. The main work of this paper was as follows: first, the hybrid cloud for chronic disease health information sharing was modeled. Secondly, the implementation of the separable electronic health records in the hybrid cloud mode is proposed to solve the sharing problem of multiple stakeholders. The third uses python to implement a cross-platform prototype client.

This paper proposes a solution to the current challenges of health information sharing for chronic diseases, and proposes a new model of health information self-management for patients with chronic diseases, which enables patients to have a higher quality of life. In addition, the collection of comprehensive patient data has potential benefits for improving chronic disease research. In addition, the study addressed patient safety and privacy concerns through patient sharing.

7. Discussion

References 1-4 describe the current problems with health information storage, but do not suggest solutions. Literature 5 puts forward the application of hybrid cloud in electronic medical records, but does not pay attention to the needs of patients with chronic diseases. Literature 6-9 puts forward several big data processing methods of electronic medical records, which have certain reference significance for the processing of health big data of chronic diseases. Literature 12-15 only focuses on the data needs of medical institutions and has no principle for implementation. The significance of this paper is that it integrates relevant technologies and addresses the needs of doctors, patients, and research institutions. How to realize the encrypted transmission of information in the next step will be the research direction of the project team.

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