

# Analysis of blockchain to help medical record data circulation and governance reform

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**Abstract.** Traditional medical records have many problems: First, it is easy to be lost and damaged, and the cost is high. Second, it is easy to cause moral hazards such as medical information disclosure and tampering; Third, medical information is fragmented and cannot be shared. The problem of isolated medical information makes the management cost and credit risk of medical data circulation in China high. Using the characteristics of blockchain information could not be tampered with, decentralization, credible consensus mechanism, not only can solve the high information cost, poor information security and isolated medical information problem, but also boost circulation and sharing medical data by the blockchain, which can make the parties mutually beneficial and win-win, boosting the epidemic prevention and control and traceability, promoting public health management modernization, enhancing the level of public health, improving the efficiency of government data governance.

**Keywords:** electronic medical record; blockchain; medical data; circulation and sharing

## 1. Introduction

The problem of medical information isolated island is the pain point of traditional medical industry. Sharing medical data can save medical resources, optimize diagnosis and treatment plans, improve medical quality and efficiency, and promote the development of public health and health undertakings with extensive value. The rapid development of blockchain technology has brought the research and application of global blockchain to an unprecedented climax. However, there are still many practical difficulties and industry pain points in realizing the sharing and circulation of medical data in the practice of the medical industry.

Blockchain has great advantages in helping medical data sharing as a distributed, decentralized and non-tampering database. In the medical field, scholars at home and abroad have made many explorations and proposed some blockchain solutions to the current data sharing problems in the medical system. Xue Tengfei, et al. proposed a blockchain based electronic medical information sharing model to solve the problem of difficult medical information sharing [1]. CHEN et al. designed a blockchain patient online communication model to share medical data and meet the online communication needs of patients on the premise of ensuring patient privacy [2]. HE Mian-jin and CUI Yi-ming expounded the impact of information asymmetry on Contemporary Chinese doctor-patient relations and proposed data information sharing starting from the interests of patients [3]. YANG Yu-ting and CHEN Min designed the architecture and functions of the blockchain medical data traceability system, trying to find the path to trace medical data through the blockchain [4]. CHEN et al. believed that in medical practice, it is necessary to strengthen the management of security and privacy leakage, data heterogeneity, data isolated islands and other problems in medical data [5]. RAJU S et al. proposed the idea of building a data bank through blockchain technology to manage education and medical data. SHAE Z et al. proposed a blockchain platform architecture to help medical clinical trials and precision medicine. XIA Q et al. believed that the patients' medical records may face risks, such as privacy leakage and economic loss during the transmission process. AHRAM T introduced a blockchain based healthcare application. The above various ideas or solutions of blockchains in the medical field are generally based on the computer system algorithm and architecture design perspective of the blockchain, as well as functional technology perspectives, such as information storage and sharing, drug traceability and anti-counterfeiting, medical fraud and claim settlement, and lack of logical research on the solution of blockchain to data information isolated islands, specific visual application scenarios and service scenarios, nor did it combine the current pain points of the industry and the situation of epidemic prevention and control, nor did it stand in the perspective of government data governance. This paper attempts to start with the three pain points of traditional medical data medical records, explore the functional logic mechanism of blockchain technology to help medical data circulation, present the application service scenario of blockchain to help medical data circulation system platform, and build a transparent, efficient, equal and shared blockchain based medical data circulation information system that connects patients, doctors, hospitals, and regulatory authorities to promote the circulation and sharing of medical data, help the epidemic prevention and control, and promote the innovation of government public governance.

## 2. Analysis of pain points in traditional medical record industry

### 2.1. Traditional medical record information is easily to be lost and damaged with high cost

Traditional medical records are scattered, inconvenient to be carried, easily to be lost with high management cost

and waste of human and material resources. Even the electronic medical records are not held by the patients independently, which medical record information is stored in the hospital system. However, the medical system of each hospital is provided by different software vendors, and it is impossible to effectively understand the medical history when seeking medical treatment in different places or different hospitals. The problems of repeated examination, excessive consultation and asymmetric information between doctors and patients are serious. The separation of medical information makes it impossible for medical information to flow and share effectively, increasing medical costs and reducing medical efficiency and quality.

## **2.2. Prone to moral risks**

Most of the traditional medical records are paper medical records, even electronic medical records. If medical personnel have dereliction of duty or the system is attacked by hackers, this medical information has moral risks, such as disclosure, tampering and illegal theft, infringing on the privacy of patients and threatens the property and personal safety of patients. Meanwhile, patient medical record information has commercial value and national public health security value as personal and medical electronic assets. Electronic medical record information is stored in a centralized database whose authority authentication only relies on the authority control of a single system, which is vulnerable to attack. Therefore, the hidden danger of moral hazard is large and the cost of market governance is high.

## **2.3. Traditional medical data information cannot be shared**

At present, when the same patient visits different hospitals or other places, the medical data is not shared. For patients, they need to re-register for consultation and receive various repeated examinations, which will cause unnecessary time cost and financial cost. For medical staffs, they spend a lot of work energy internally, resulting in a waste of medical public resources. Meanwhile, the past medical record data is broken, and it is difficult for medical personnel to obtain the patient's past medical history comprehensively, may leading to medical judgment bias, decision-making errors, and delay the illness. Repeated visits by patients also delay the best treatment opportunity, prolong the suffering of patients and even cause more serious life risks. The medical data information of different patients in the same condition is also an important resource for medical consultation and medical research. If it cannot be circulated and shared, it will lose its valuable medical research value and social value, which is a loss to the development of human medical cause.

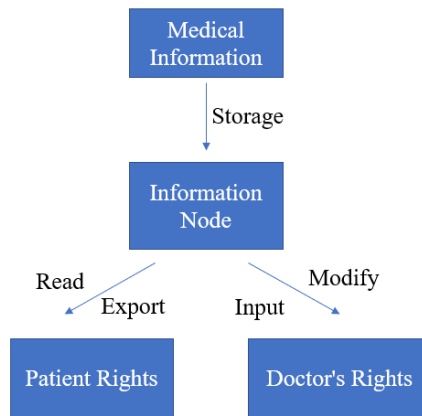
Generally, the traditional medical records have the problems of high cost, moral risks, such as information leakage and tampering, medical information isolated islands and high governance cost of data circulation market. The blockchain technology can solve the above problems. In 2020, the Ministry of Industry and Information Technology released the White Paper on China Blockchain Technology and Application Development 2020, pointing out that the exploration and application of blockchain has developed into various fields and gradually become rational. As an emerging industry with rapid development in recent years, blockchain has expanded many application scenarios, such as information security, data services, digital finance, supply chain management, anti-counterfeiting and traceability, copyright protection, and social entertainment [6], relying on its characteristics of distributed ledger, decentralization, consensus mechanism, and ability to ensure the authenticity and non-tamperability of information.

The blockchain electronic medical record system is a specific scenario application of the blockchain medical data sharing and governance reform. Its construction and implementation is a rare development opportunity for medical informatization. The implementation and implementation of its specific application scenario is an urgent problem [7]. Particularly, under the public health governance crisis of COVID-19, all countries need to urgently solve the shortcomings of traditional medical data, and strengthening the advantages and characteristics of medical data governance, blockchain decentration, high transaction efficiency and low maintenance cost make up for some pain points of traditional medical records system, such as low security, not held by users, hard data information sharing, etc.

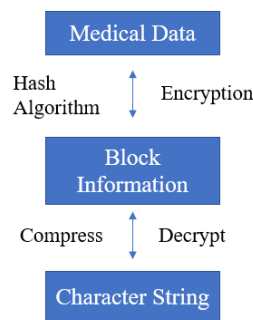
## **3. Implementation path for blockchain to help medical data circulation and governance reform- blockchain electronic medical record system platform**

As shown in Figure1, the blockchain technology is used to store the patients' medical information on the information node of time stamp for the pain points of traditional medical records that are easily to be lost and damaged. This cannot only save medical costs, but also solve the problems of loss and damage of traditional medical records. Because the blockchain uses cryptography and digital signature to protect data and verify transactions, and the chain structure blocks are stamped with time stamps, the information on the chain is non-tampering and traceable. Meanwhile, the blockchain can be used to set the rights of patients to read and export medical information and doctors to input and modify medical data. Certainly, the modification right shall be confirmed by the patient. This also solves the unfair problem that doctors have the right to read and input electronic medical records in the current hospital, and patients do not have the right to read. If patients face with medical accident liability disputes, the traceability characteristics of blockchain electronic medical record information will play a role. Whether it is the responsibility of the patient, the doctor or the medical institution can be accurately traced through simply calling the hash data under the "Time Stamp" in the system. The information of the hash value provides evidence for the division of responsibility in medical

disputes.

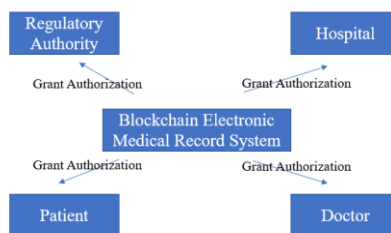


**Figure 1.** Medical information storage principle of blockchain electronic medical record system



**Figure 2.** Medical information data encryption principle of blockchain electronic medical record system

As shown in Figure 2, a medical data is encrypted by the hash algorithm of the blockchain for medical information is prone to moral risks, such as information disclosure and tampering. Here, the medical data of a patient is equivalent to a block of information. The information content is compressed into a string composed of letters and numbers. The string represents the original content of personal medical information, but it shall be parsed by a specific hash algorithm. The hash value is equivalent to a secret key. It is a key that can uniquely and accurately identify a block and cannot be tampered with. Meanwhile, the decentralized feature of the system ensures that the information between the blocks can interact directly, and any node damage will not affect the operation of the whole system, ensuring data security.



**Figure 3.** Medical information sharing principle of blockchain electronic medical record system

As shown in Figure 3, as medical information cannot be shared between patients and different hospitals, the blockchain electronic medical record system can be regarded as a third-party platform, serving as a bridge between patients, hospitals and regulatory authorities. Each block on the blockchain electronic medical record system is a transaction record shared among participants. Because the ledger is distributed, the hash value is generated by the blockchain technology system, so that each data information node stored on the blockchain can support the legitimate users of patients, doctors, hospitals, and regulatory authorities, etc. to obtain system permissions and access public data. Quadripartite users with access can register on the platform, patients can read and export information, doctors can enter and query information, and medical institutions and regulatory authorities can export medical data from the platform. As a connecting bridge, the platform integrates patients, doctors, medical institutions and regulatory authorities, and realizes medical information sharing and mutual supervision among these four parties.

As shown in Figure 4, the blockchain electronic medical record system can be composed of three parts, namely, the user use module, the medical record authority management module and the user wallet module. The user uses the real name of the ID card to register and log in the user use module; When the user applies for data record uploading at the end of medical treatment in the medical institution, the hospital will declare the record through the client, and the generated medical data information is automatically stored in the blockchain information node. When the user visits the

hospital again, he/she can view the record through the client or authorize the doctor to view it, and then give a diagnosis conclusion according to the past medical record information of the user. The authority management of medical records refers to the secret key management of the system based on the blockchain technology. The management system module is mainly used for identifying the transaction data sent by the user, confirming the transaction data, executing the transaction record into the block, agreeing and validating the transaction information in the block. The access record management of medical records can enable each information node to support multi-level access control through the hash value generated by the system. Patients have the right to read, and medical institutions have the right to enter to meet the security management of blockchain medical records. Patients can read and authorize each medical institution Under the advantage of data sharing by third parties, making it more convenient for patients to visit. The user wallet module can be used for paying medical record management fees, hospital registration fees, and online medical fees. Not only that, the wallet can have both financial and financial functions, and the money fund financial products with low risk can be used as the user's choice. Meanwhile, the subsidies and government medical assistance obtained in the corresponding medical clinical trials can be automatically saved into the wallet, which supports third-party payment, making it more convenient for users to use.

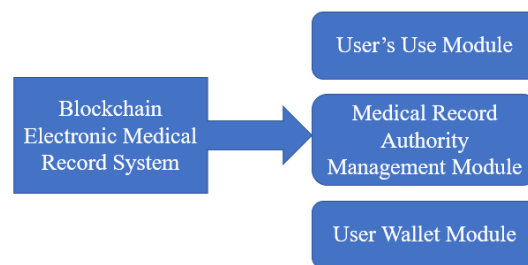


Figure 4. Functional structure diagram of the block chain electronic medical record system

As shown in Figure 5, the application scenario of the blockchain electronic medical record system is that medical institutions authenticate, authorize and obtain public and private keys through the government authoritative certification center, and medical institutions authorize and sign agreements. It is released to the blockchain medical data storage system after the information is encrypted. Subsequently, individuals or third-party institutions shall be authorized to obtain information, and the information is searched and decrypted. Patients seek medical treatment in different medical institutions in the current medical records. It is a major challenge for the big health data industry to ensure that various medical records are complete and that high-density information can be stored and shared. The electronic medical record system based on the blockchain technology will help different medical institutions to read and share medical record data information. This is a strong competitive advantage of the electronic medical record system based on the blockchain technology.

The pain points of medical data sharing lie in the privacy protection of patients' personal information and the safe reading of data by multiple organizations according to relevant survey data. Because the whole blockchain electronic medical record system is a multi-party maintenance, full backup and non-tampering system, all the data transmitted are encrypted and irreversible hash values, which also fundamentally ensures the confidentiality of patient information. When a patient visits a doctor, the authorized doctor can view the past visit data and indicators as a diagnostic reference. The safe and true information on the blockchain medical record system is convenient for doctors to refer to and quickly realize accurate treatment and health consultation.

Medical data were stored on the servers of various medical institutions in the past, which could not be accessed externally, and it was difficult for the regulatory authorities to achieve supervision. The regulatory authorities can access medical records after authentication using blockchain authentication and authorized access technology; patients can master their own medical data through authentication, and can also be authorized to access other nodes on the platform. Meanwhile, medical institutions can carry out service quality supervision over the whole process of medical behavior.

#### **4. Some thoughts on blockchain helping medical data circulation and governance reform**

##### **4.1 Medical informatization and democratization**

Electronic medical record data information is not only the personal information assets of patients, but also related to the interests of hospitals and the health and safety of patients. The information blockchain has the characteristics of non-tampering and traceability. Once the data is entered by the patient in the blockchain medical record system, it will be saved in the account book of each node, which is recognized and verified by the whole network and is valid, and cannot be tampered with. This ensures the authenticity and integrity of patient data information storage, avoids malicious tampering of information, and improves the reliability of medical information.

If it is necessary to trace and query medical data, the characteristics of blockchain distributed storage ensure that all medical institutions can obtain the same electronic medical record data from any node, and will not be unable to obtain data due to damage of a node, resulting in data loss; The encryption technology features ensure the security and authenticity of data transmission, prevent data from being tampered with arbitrarily, and ensure the quality of electronic medical records. So, the medical investigation required by medical research or medical disputes has evidence to follow,

promoting the scientific and democratic development of medical information services [8].

#### 4.2 Medical enterprise development and medical data governance efficiency

The combination of blockchain and medical data system ensures the transparency, authenticity and reliability of medical information, realizes the circulation and sharing of medical data and the trustworthiness and verifiability of medical information, which is benefit for the real-time monitoring of medical data by regulatory institutions, and automatic and intelligent supervision of the authenticity of medical behaviors, rationality of medication, medical treatment process and medical expenses, to ensure the safety, compliance and rationality of medical diagnosis behaviors and medical funds, prevent the risks of medical and health care, and demonstrate the civilization and progressiveness of data in the digital economy era [9].

At present, the global COVID-19 epidemic is normalized, and the blockchain technology helps medical enterprises to prevent and control the epidemic and trace the source, improve the credit mechanism of medical data, improve the level of public health and improve the efficiency of government public health governance. The problem of medical information isolated island is the pain point of the traditional medical industry, and the sharing of medical data is the embodiment of the government's governance efficiency while facing public health crisis. As one of the important breakthrough directions in the reform of government governance efficiency, blockchain will certainly have great potential, and its application in the field of medical and health services will have indispensable important value. The medical record data recorded by the blockchain electronic medical record data platform can be traced according to date, disease type, and region, etc., providing data support for the government to strengthen health management. Meanwhile, the government's participation can also enhance the credibility of the platform and promote the healthy development of the entire medical and health industry.

At present, the application of blockchain in the medical industry and the use of service scenarios are not deep and detailed. Relevant policy support and business thinking are still needed to promote the popularization and application of the blockchain electronic medical record data system sharing platform. For example, the business model to be adopted, the unified blockchain health industry standards, the introduction of blockchain technical guidelines, the effective consensus mechanism and incentive mechanism, the sharing and supervision of medical data circulation, and how to form a sustainable mechanism for sharing and mutual supervision of medical information among patients, doctors, hospitals and regulatory authorities need to be solved.

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