

Perspectives

Application of 'Blockchain Plus Public Health'

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On October 25, 2019, senior Chinese officials conveyed the significance of blockchain to all sectors of society through the 18th Collective Study of the Political Bureau of the Central Committee of the Communist Party of China. Blockchain is the distributed ledger that maintains a growing list of chronological blocks linked by cryptographic techniques. It is a combined innovation of peer-to-peer networks, cryptography, consensus protocols, smart contracts, etc., which offers tamper-resistance and traceability characteristics to solve trust issues (1–2).

Since blockchain is a promising technical infrastructure to promote the upgrading of strategic sectors, and industries are actively seeking to understand and apply it. 'Blockchain + Public Health' has also been recognized as a vital research direction.

To regulate blockchain application, the Cyberspace Administration of China issued the Regulations on the Management of Blockchain Information Services on January 10, 2019 that came into effect on February 15, 2019 (3). Based on the application scenario, blockchain systems can be classified as public, consortium, or private systems.

GLOBAL BLOCKCHAIN APPLICATIONS

Blockchain has received great attention from academics and governments worldwide. It is gradually moving from conceptual research to integration with the real economy. China is in a leading position to explore industrial blockchain applications (4). In 2016, blockchain technology was included in the 13th Five-Year Plan for National Informatization Planning for the first time.

Currently, there are three typical blockchain applications in the public health field:

1) Applications for data integration and sharing. Researchers at Sichuan University designed a league blockchain system for infectious disease data, named the Virus Database Chain (VD Chain), based on Practical Byzantine Fault Tolerance (PBFT). The system was used for integrating and sharing infectious disease surveillance data to overcome the difficulty in

information sharing and to reduce the risk of data security caused by random sharing. The system was based on a structure composed of five layers: data, network, consensus, contracts, and application. Data from CDCs, medical institutions, and health administrative departments are stored in blockchains or databases, and the system also provides a client interface at the application layer for information query and management (5).

2) Applications for tracking vaccines. The non-tamperability, unforgeability, and traceability of blockchain offers significant advantages in tracing the source of vaccines. Several institutions and individuals have developed blockchain-based vaccine full-life-cycle surveillance approaches and systems (6). The basic idea is to determine the blockchain nodes corresponding to the parties involved in vaccine management and to build a league blockchain, in which each party in a certain link of the vaccine life cycle represents a node. The manufacturers, supervisors, managers, transporters, and vaccinators publish and retrieve data generated during vaccine manufacturing, distribution, use, and management in the league blockchain to ensure that the information is tamper-proof and traceable.

3) Applications for Personal Health Record (PHR) exchange. In a study conducted in Taiwan, China, a blockchain-based PHR exchange architecture and management platform was designed to secure the transfer and sharing of PHR data between patients and medical health care providers. The platform comprises two main components. The first is the PHR management platform, which performs the functions of viewing PHRs for personal health management, sharing PHRs with a doctor, and securing the blockchain content. The second component is the blockchain exchange architecture based on Ethereum for creating a private chain. The platform has been recently deployed in Southeast Asian countries (7).

Electronic Health Record Management: Chinese medical institutions generally lack overall information plans. Health data is scattered among medical systems and hard to share. Blockchain is well suited for the

construction and management of electronic health records (EHR). The medical consortium blockchain will unify patient records into a unique ‘health ledger’ that can be shared among related institutions. Through safe circulation and storage, the updating, accuracy, and integrity of EHR have been greatly improved. In addition, the system greatly reduces the institution’s data obtaining costs.

Vaccine Traceability and Management: The life cycle of vaccines involves pre-development, testing, approval, production, quality inspection, procurement, storage, transport and inoculation. Problems in any link will affect the vaccine quality. Therefore, quickly obtaining the tracking data can help identify problems. The traditional system uses Internet of Things (IoT) devices to obtain production, cold chain storage/transport, and inoculation information. However, the information is separated and controlled by the institutions, which is vulnerable to tampering. In contrast, a blockchain records all information in a decentralized way, which prevents data tampering and guarantees its authenticity.

Vectors and Pathogens Monitoring and Management: Electronic evidence recording is the technical process of electronic data collection, collation, storage to secure integrity. There are currently two major bottlenecks in vector and pathogen monitoring. One is that authentication methods and access standards for test data have not been fully developed for laboratory networks. The other is that the risk of tampering with laboratory test data makes it difficult to implement credible evidence chains.

A blockchain-based electronic evidence system can provide reliable and traceable digital certification for monitoring. Blockchain technology can be used for quality control and whole-process inspection. A blockchain system can monitor and process vector and pathogen data to promote information management and sharing. With rational rules and incentive mechanisms (8), blockchain can be used to establish a credit-based quality-control system for testing laboratories.

BLOCKCHAIN APPLICATION CONSTRAINTS

A key problem of industrial blockchains is the lack of necessary technical standards and specifications, including basic technology, blockchain business

standards, and application specifications. Therefore, blockchain applications have some constraints.

Decentralization. Decentralization is one of the most significant features (9) of blockchain. However, a completely decentralized blockchain without central authority is incompatible with national public health supervision. A consortium blockchain is more appropriate for public health.

Openness. Openness and sharing are blockchain’s foundation. The blockchain ledger is open to the public and highly transparent (8). However, since personal health information is sensitive, we must pay special attention to privacy protection.

Independence. Through cryptographic algorithms, nodes can automatically exchange and verify blockchain data (8). Most blockchain systems use open-source cryptographic algorithms. However, Chinese blockchain applications must support the domestic cipher algorithm for higher security.

Security. As long as 51% of the nodes are honest, blockchain system will not be manipulated. Therefore, blockchain systems have relative rather than absolute security, which may not meet industrial standards for data security. Besides, blockchain’s multiple backups may arouse information security concerns.

Anonymity. Technically, blockchain nodes do not need to disclose their identities for information transmission (8). However, real-name authentication is required for consortium blockchain.

REFLECTION

Consortium blockchain is the optimal blockchain-based public health schema. Currently, most industrial applications adopt the consortium blockchain, which forms the multi-center trustworthy ‘ecosphere.’

Furthermore, smart contracts can determine ownership in real-time, which achieves automation, openness, and transparency. When faced with emergencies, departments can track the circulation quickly to enhance accountability.

The autonomous and controllable standards and specifications are prerequisites for implementing blockchain applications, including application scope, data standards, and technical and interface standards. The consortium blockchain platform provides secure data registration services and service docking. Therefore, service providers can develop blockchain applications with the standard framework and its programming interfaces. Besides, with these standards, reliable public health monitoring data trading system

can be established, in which separate information can benefit the entire system to improve traceability and accountability. In addition, security issues in blockchain need to be highlighted (10).

In conclusion, the blockchain application in public health is very promising, but only a secure and controllable system can be widely used in China.

Funding: National Natural Science Foundation of China: Study and demonstration applications of a big data integration and sharing platform for public health and major diseases (91846303).

doi: 10.46234/ccdcw2020.201

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Submitted: May 20, 2020; Accepted: August 28, 2020

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