

Role of Blockchain Technology in Health Record Management

Shivani Pramod Gupta, Keshav Kumar*

Abstract

Maintaining thorough medical records is essential to raising a healthy population in the fast-paced world of global development. Intimidating data breaches have been the consequence of the traditional centralized strategy to maintaining health records, yet it has proven vulnerable. The 2017 Ponemon Cost of Data Breach Study estimated that each compromised healthcare record could incur a significant cost of approximately \$380. Regrettably, the 2016 Breach Barometer Report revealed that case records have been compromised. A mindset shift is necessary in order to admit the limitations of institution-driven record conservation. Individualities under the present models are not empowered, which makes their sensitive data vulnerable to abuse. Thus, a radical, decentralized, and case-centered approach is needed, one that gives the patient complete power. Blockchain technology provides a game-changing answer ready to take on these problems head on. The problems of conventional record-keeping are greatly reduced in a decentralized and distributed tally system like blockchain. Piecemeal from mollifying data breaches, blockchain holds the capability to transfigure other aspects of the healthcare assiduity, similar as billing procedures, safe record-sharing, progress in medical exploration, and a strong hedge against identity theft and fiscal data crimes. A fresh position of complexity has been added with the preface of smart contracts, which streamline operations by automating processes like record creation, confirmation, and incantation directly on the blockchain. By exercising blockchain technology, the healthcare assiduity can guarantee the confidentiality of patient data and pave the path for a day when patient autonomy, data security, and openness are of utmost significance. This creative strategy not only protects people's health but also ushers in a new period of effectiveness and confidence for the healthcare sector. In addition to utilizing blockchain technology, this paper suggests integrating smart contracts into a patient-driven healthcare record system. A revolutionary effect on healthcare data management is predicted, and it highlights the need for additional study and real-world application.

Keywords: Decentralization, blockchain, immutability, cryptographic hash, smart contract

*Author for Correspondence

Keshav Kumar
E-mail: krkeshav409@gmail.com

Research Scholar, MCA, Thakur Institute of Management Studies, Career Development & Research (TIMSCDR) Mumbai, Maharashtra, India

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INTRODUCTION

Both societal prosperity and personal happiness depend on human well-being. Its influence goes beyond individual satisfaction, it affects a country's economic development. Everyday obstacles such as sickness, mishaps, and crises highlight the importance of prompt disease diagnosis and treatment. The health record is a collection of clinical information from various sources that represents a patient's physical and mental well-being. This all-inclusive database includes lab results, scanning reports, diagnoses, treatments, medical history, exams, and critical alerts like allergies. These health records are managed in a

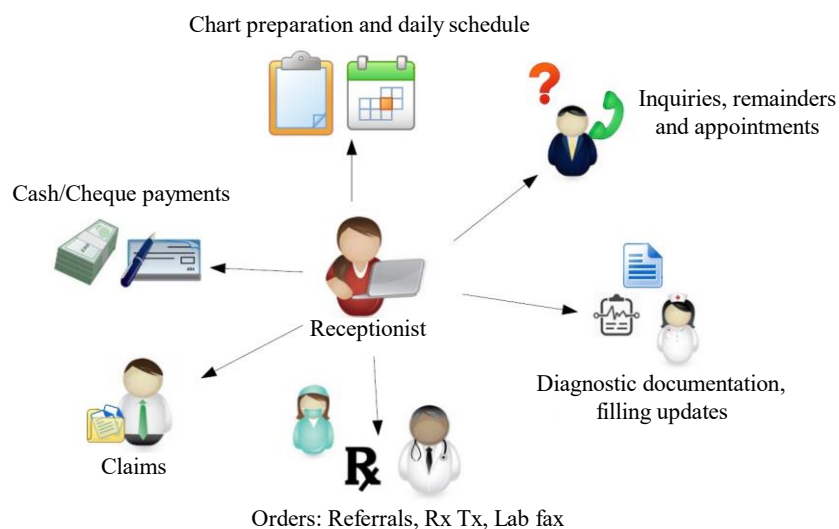


Figure 1. Existing centralized healthcare model.

flexible way that can accommodate the efficiency of digital technologies as well as the meticulous manual methods.

Hospital record-keeping practices currently in use mainly rely on labor-intensive manual techniques with papers and books (Figure 1) [1]. The problems with this traditional approach are that it takes up a lot of storage space and can be laborious to retrieve records. Clinical record computerization [2] has become more common in today's environment because it makes storing and retrieving records easier. This digital approach, though, raises questions about the possibility of manipulation without appropriate identification. Another major challenge is maintaining patient records in a confidential way, since patients trust their doctors and hospitals to protect the privacy of their medical history [3].

Incomplete medical records on paper frequently result in unnecessary testing and prescriptions. Because this system is dispersed and non-centralized, it is inefficient, as demonstrated by the time lost on manual transfers via mail or fax [4]. To make matters worse, doctors' access to medical records is restricted. Digital technology integration into the healthcare system facilitates quick and easy health record sharing between medical facilities in order to address these problems [5]. Nonetheless, issues with data storage, access authorization, and the security and unchangeability of patient data come up. The creation of a decentralized digital health infrastructure—achieved by incorporating blockchain technology into the healthcare system—is the answer. Rebuilding the modern economy is one of the transformative potentialities of blockchain technology.

BACKGROUND

Blockchain Technology

A blockchain functions as an unalterable, distributed ledger for storing transaction records, with each block timestamped and linked to the previous one through cryptographic hashes, forming a chain of interconnected blocks [6]. We get a clear picture of how a blockchain works only when we explore how a blockchain network runs.

In a peer-to-peer network, each node maintains a record of all transactions conducted within the network, with every node possessing its own wallet for transactions. Users interact with the network through a pair of cryptographic keys: a private key for signing transactions and a public key visible to all nodes. To initiate a transaction, a user signs it with their private key, creating a digital signature when combined with the public key. This signed transaction is then broadcasted to the blockchain network, where it undergoes verification by miners [7].

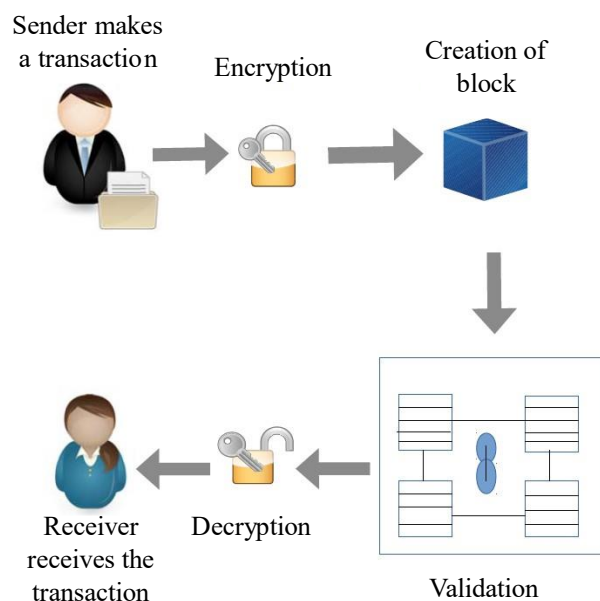


Figure 2. Working of blockchain technology.

Miners, nodes with significant processing power, ensure the transaction's integrity and irreversibility through a consensus mechanism known as proof of work. Miners compete to generate valid blocks, with the successful miner rewarded, as depicted in Figure 2.

A block of transactions is approved only when it has been verified by every miner on the network. The block becomes a legitimate block and is automatically added to the larger blockchain once the transaction is validated by more than 50% of the miners [8].

LITERATURE SURVEY

In this section, we focus on the different efforts aimed at protecting healthcare records, the obstacles encountered, and potential remedies.

In their paper titled “Towards Using Blockchain Technology for eHealth Data Access Management,” the authors explore the advantages of blockchain, and the specific challenges associated with securely implementing health records [8]. They provide an architecture that addresses the difficulties associated with e-health applications and suggest a scalable way to maximize performance. With the help of smart contracts and an off-chain database, physicians and hospitals function as networked nodes connected to the e-health blockchain. Through a data gateway, patient interaction with medical sensors and the blockchain is made possible. The paper highlights how the careful application of tools, models, protocols, and blockchain technology can lead to the implementation of fully functional systems that will revolutionize future applications.

Using a Decentralized e-Health Architecture to Revolutionize Healthcare Analytics

The paper “Decentralized e-Health Architecture for Boosting Healthcare Analytics” discusses security concerns and the complexities of medical data analysis [9]. The authors aim to improve healthcare services by presenting a blockchain solution that is specifically designed for state-level healthcare and makes use of the Exonum framework. Peer-to-peer connections connect the nodes in this solution, and each node is authenticated using a public key. The potential of Blockchain in managing large amounts of clinical data and protecting patient privacy is highlighted in the paper. It also emphasizes the creative possibility of developing a data-driven market in which patients can participate in medical analytics by having access to a data monitoring tool. Additionally, individuals choose to donate their data to medical and research institutions.

Investigating Blockchain as a Potential Fix for EMR Security and Interoperability Issues in Developing Nations

To guarantee continuous availability and real-time data access, the authors of the paper “Is This the Solution to EMR Interoperability and Security Issues in Developing Countries” [5] focus on integrating blockchain technology with electronic medical records (EMRs). The research evaluates current health record maintenance techniques using the case study of an EMR in Kenya, highlighting the revolutionary role that blockchain plays in boosting system security and interoperability. Blockchain gives patients complete control over sharing preferences and full access to their data. Furthermore, it uses cryptographic methods to enable trustless network interactions [5]. Encryption preserves patient privacy as patient information is shared amongst stakeholders, resolving important issues with EMR systems.

Leading the Way with Blockchain in Healthcare

The paper “Introducing Blockchain for Healthcare” explores different blockchain architectures, current problems, and possible fixes [10]. Blockchain makes it easier for healthcare providers to create smart contracts and allows access to patient records and specific data, but it raises questions about data access authorization and identity. In order to deter potential attackers and address security challenges like Sybil attacks, miner nodes are required to solve mathematical problems prior to adding a new block to the blockchain. In order to improve blockchain's effectiveness in healthcare, the paper also raises concerns about things like the inference of private data, which has led to a request for creative architectural designs that defy existing cryptographic algorithms.

MEDICAL DATA MANAGEMENT ON BLOCKCHAIN

Contemporary healthcare systems employ digital techniques for managing patients' medical records. At the moment, critical patient data, diagnostic results, and prescription drugs are stored centrally in healthcare organizations. Patient control over their data is limited by this centralized system, and the exchange of recorded data is a laborious and complicated process, increasing the risk of data leaks and exploitation. We suggest utilizing blockchain technology to move from a centralized to a decentralized system in order to overcome these difficulties. Understanding the breadth of data and its points of generation is essential for integrating blockchain into the healthcare industry in Figure 3. Sensitive medical data is produced by healthcare organizations at every point of care, from consultations to different medical procedures, diagnosis, and surgery. The medical data includes a number of important components, such as prescriptions written by doctors, diagnostic pictures (magnetic resonance imaging scans, X-rays, ultrasound reports), and specific medical procedures (radiography, endoscopy, angiography, etc.). Additionally, it contains private health information like diagnoses for cancer or HIV as well as psychological disorders.

To improve data quality, value must be added before data is added to the blockchain. To prevent inconsistencies and treatment process delays caused by unstructured data, patient medical records should be precise, comprehensible, and organized. The idea is to use blockchain technology to disperse digital health records among several network nodes in order to reduce the risks associated with centralized data storage. Better security and control over private medical data are ensured by this decentralized method.

Patient health records are safely kept on the blockchain network by using their public keys. Transactions that involve patient health records are associated with distinct IDs and the public key of the patient. Smart contracts allow healthcare organizations to access non-identifiable patient data, guaranteeing access only when unique IDs match. Patients can choose to give health organizations access to their public key, but the data cannot be identified without the private key. In order to ensure that data is shared and retrieved voluntarily, smart contracts are essential.

In essence, smart contracts are self-executing agreements in which the terms of a contract between two parties are represented as code, obviating the need for a third party.

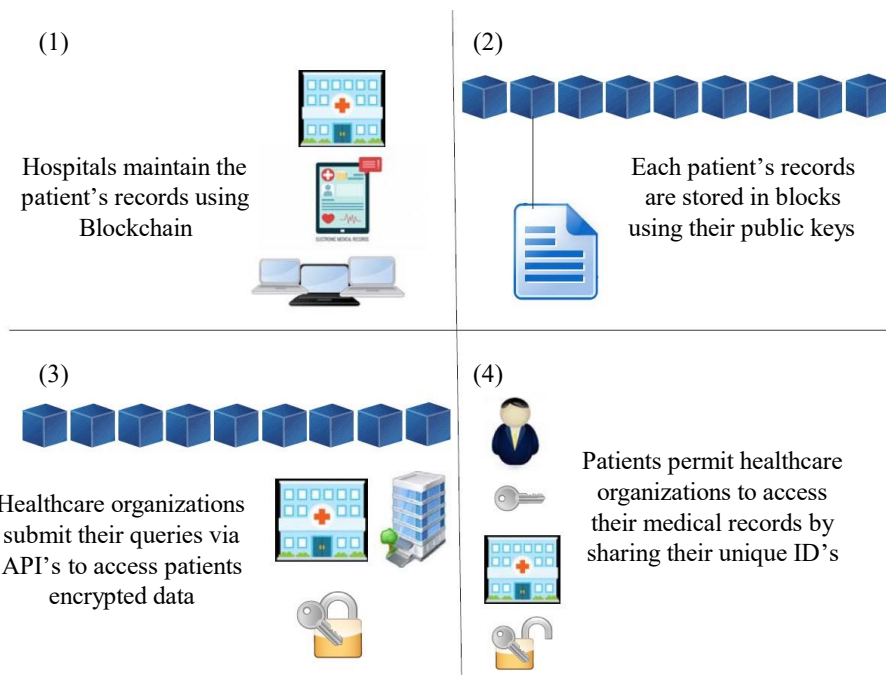


Figure 3. Process of managing health records.

They function as a protocol that enhances security and transparency in data transactions within the healthcare ecosystem by digitally facilitating, enforcing, and verifying contract negotiation or performance. The suggested concept for our project is a contract called “healthcare,” which consists of two nodes that stand in for different entities, like lab admin and hospital admin.

A “record,” which includes the patient's address, unique ID, test results, date, hospital name, price, is value, and number of signatures, is a newly introduced structured element.

Invoking the Transaction

We created a public constructor that launches the app automatically. On the blockchain network, transaction invocation is limited to the hospital administrator, who designates and allots a particular address to the lab administrator.

New Record Creation

The patient data is kept in an array called “Records,” and we have included a function called “newRecord,” in our deployment. By giving values to the appropriate parameters, this function makes it possible to add new data to records that already exist, making record management on the blockchain more efficient.

Validation

We have developed a function called “signRecord” to validate records. This function counts the number of signatures to determine if the new record already exists in the record array. The hospital administrator signs the transaction in the event that the count is '0,' signifying the absence of the record. In case the record is already in existence, the count of signatures is reset to '1,' and no additional signing takes place. An event called “recordSigned” is emitted when the number of signatures reaches “2,” signifying that the record has been successfully validated and signed.

The security and integrity of the blockchain network's record validation procedure are guaranteed by this methodical approach as illustrated in Figure 4.

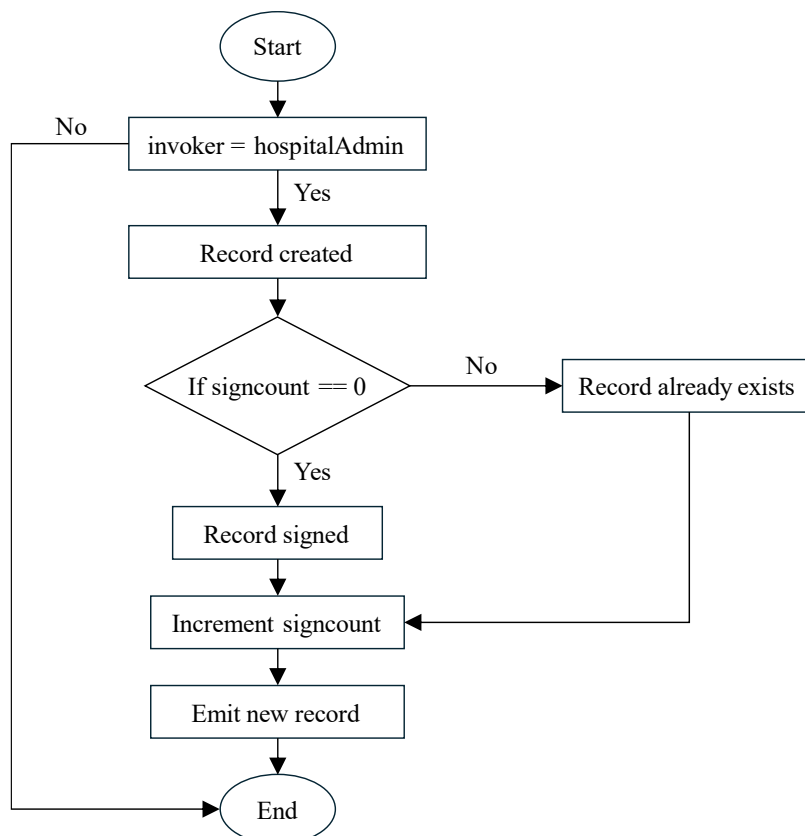


Figure 4. Flowchart of the smart contract.

CONCLUSION AND FUTURE WORK

As the proverb says, “health is wealth,” we can expand this to say that health records are a type of wealth in the modern world. The security of our medical records is now crucial. Patients now have on-demand access to their health records, reflecting a new paradigm reflected in the global shift toward patient-driven interoperability. This model acknowledges patients as the exclusive proprietors of their medical records, giving them the authority to choose which information to disclose and with whom.

The shift from an institute-driven to a patient-driven approach presents a number of challenges that blockchain technology successfully resolves. Blockchain decentralizes the entire process, which differs from traditional data management methods. Sixteen percent of 200 health executives who participated in a survey by IBM's Institute for Business Value Blockchain said they are ready to implement commercial blockchain. Blockchain goes beyond decentralization to offer real-time data access, data confidentiality, efficient handling of massive volumes of data, and data authentication and authorization, making it a strong solution for the changing health record management landscape.

Our strategy includes the use of smart contracts, which are essentially pieces of self-executing code that take action on their own when both parties consent to a predetermined set of protocols. In this situation, the patient represents one end user and the hospital administrator, the other. Three essential steps are involved in executing the smart contract: invoking, creating records, and validating.

In this paper, we present blockchain technology as a workable option for the effective upkeep of medical records. Notably, blockchain is useful not only for managing health records but also for a wide range of other industries, including banking, supply chain management, e-voting, transportation, and utility payments. We suggest that more study can help blockchain become widely used in many different fields, which will ultimately improve and simplify a number of areas of our lives.

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