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# Blockchain enabled health care recordmanagement solution in Ethereum Platform

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***Abstract***
*Blockchain technology offers incredible flexibility as many business sectors have found ways to integrate their capabilities into operations in recent years. The healthcare industry has received most of the attention so far, but some efforts in other service-related areas such as healthcare suggest that this is changing. This research focuses on the development of blockchain-based structures in the healthcare business. This article examines several of the advantages, aims, and possibilities connected with such disruptive technologies, utilising examples from the healthcare business such as user-centric medical research, prescription counterfeiting and public health management,*

## I. Introduction

The Blockchain technology has occupied each part of life, including information and communication technology (ICT, which has exploded in current years. The massive rise of cryptocurrencies, as well as substantial venture capital investments in blockchain firms, has encouraged interest and development of this expertise. By 2021, the blockchain technology industry is predicted to grow [1]. The development of blockchain has sparked incredible imagination, with an increasing demand improved cybersecurity, for a broad array of applications spanning from data management for financial institutions, the Internet of Things (IoT), also socioeconomic knowledge for the social safety engineering and psychological examination. The committee noticed strong willingness to leverage blockchain job opportunities to transfer secured and secure social safety data. Medical services are a huge sector with several challengesthat must all be addressed [2].

The ability of various parties across and within the healthcare continuous spectrum to exchange patient health information remains a fundamental barrier. Electronic Medical Records (EMR)-based systems have historically aided in the digitization and sharing of healthcare data inside a healthcare facility [3]. Personal Health Records (PHR) systems also have been promoted to aid in the management of patient data along the health continuum. In today's digital age, it is vital to communicate information such as medical data with a trusted third party. As a result, HIE network companies have grown accustomed to brokering alternate arrangements between hospitals, scientific domains, regulators, insurers, and maybe even patients. Electronic health records enabled integrated health systems (EHR) [4].

## II. Areas of healthcare where blockchain can be used

- Control of availability of healthcare data: ensures that patients have increasingly secure access to medical records.
- Maintaining the medical records: It must ensure continuous access to medicinal information in order to keep the therapeutic level record for enhanced treatment while avoiding new assets and expenditures.
- Supply chain management of Healthcare: inside social network health care frameworks, it can provide safe techniques for supply chain care and control.
- Invoice and health insurers: Blockchain-based healthcare payment solutions that are secure, faster, and less complicated can be provided.
- Sharing of medical data: It is necessary to protect the security of medical data that is stored and transferred among many partners.
- Research and medical trials: can be an useful tool for ensuring the accuracy of key examinations and clinical preliminaries

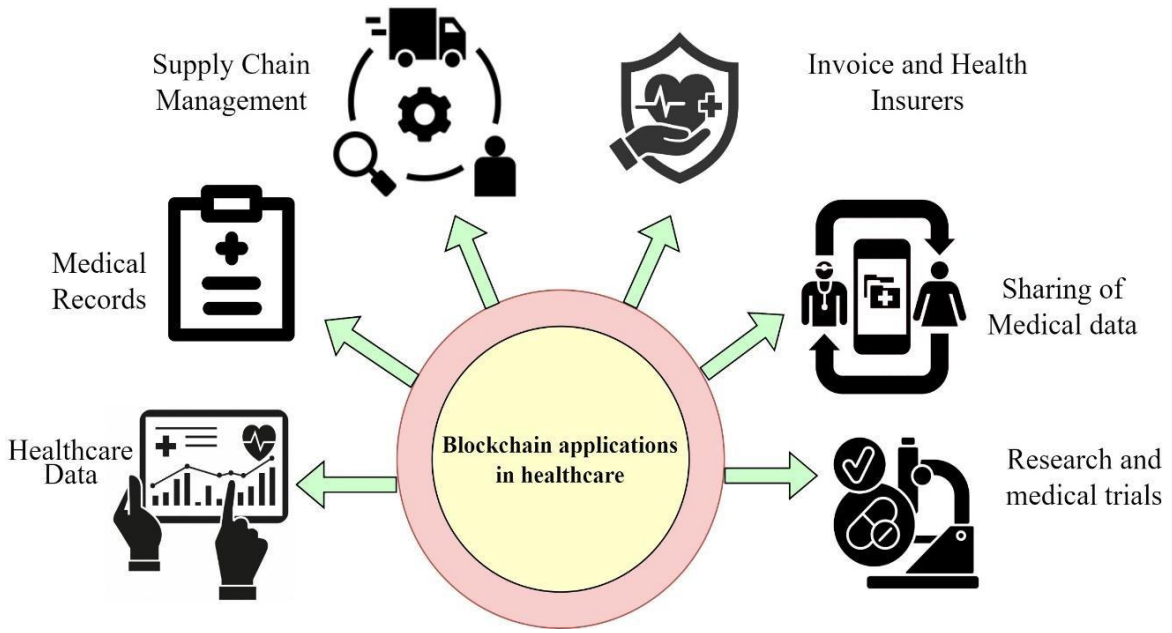


Figure 1: Blockchain Application in the Healthcare sector

Figure1 depicts the area of the healthcare sector where blockchain technology can be used and provide security as well. The Blockchain seems to be a peer-to-peer computer network, commonly known as a distributed system, that maintains a distributed, timestamped, clear, as well as fraud-proof digital ledger. A Merkle tree structure was added to the system, allowing for the storing of much more documents in a block. Decentralized, accessible, open-source- source software, persistent, or other properties of Blockchain technology are also among them. The Network layer, Data layer, Consensus layer, Service layer, and Incentive layer are total five levels that make up the blockchain architecture.

Merkle trees, which are full binary trees with two children linked by k-bits and generate 2xlog2n number of hashes for every N transaction, are used to protect and effectively encrypt blockchain data in bitcoin. The Merkle node is the root node. Cryptographic hash functions, are mathematical techniques that compress and encrypt data of any size, The basic components of a blockchain are asymmetric-key cryptography, where public and private keys are used to secure data, and ledgers as a database consisting of a collection of transactions: shared and synchronized, transactions are where data is transmitted between multiple nodes through the use of the network. Blocks are comprised of two sections.: 1) block contents ,2) block header, which used to store entries in an immutable way.

The consensus algorithms employ various approaches like Practical byzantine fault tolerance is a method capable of dealing with approximately to one-third of harmful byzantine copies, Proof of Work for publishing a transaction block in a blockchain network, Proof of stake where the total cryptocurrency that the blockchain network participant, and the primary node. Delegated proof of stake is a technique of constructing and verifying blocks in which delegates are compensated and act as Proof of authority, publishing nodes, Proof of elapsed time, Round-robin consensus, and other models remain available.

In recent decades, the blockchain technology has seen significant and exponential growth in a variety of fields. Blockchain technology is important in healthcare data management so it addresses numerous issues such as counterfeit drug delivery, future pandemic solutions, data security in clinical studies, and a single point of failure.

A cryptographically protected blockchain that assists in the prevention of information theft was introduced tampering through Timestamp documents [5]. The system has been improved and additional documents were maintained in a single block combining a Merkle tree structure. In 2008, Satoshi Nakamoto presented bitcoin as a digital ledger, and a trial was established in 2009 to technical efficiency trust in a highly decentralised environment where no one would have been able to change anything In 2008, Bitcoin was launched as Blockchain 1.0, which will have the capabilities of a digital ledger within a peer-to-peer (P2P) system [6]. The public blockchain named, Blockchain 2.0 also the Ethereum blockchain, in 2013, allowing users for greatest assets by means of smart contracts. Hyperledger, a blockchain that promotes international trade collaboration besides improving system traits and performance, was introduced in 2015 [7].

The characteristics of blockchain technology include:

- *Decentralized*: Anyone who is attached to the blockchain has access to information, which is updated, monitored, and modified by that the user.
- *Transparency:* The verified information will simply act as an open source to all or any of the users on the network.
- *Open source:* it's open because the users may additionally create their requests.
- *Provenience:* Digital signatures confirm the authenticity of information stored as a transaction.
- *Autonomy:* The user participates in the network using the generated address, and thus the user's true identity is obscured.
- *Distributed control:* The information contained within the blockchain is dispersed, and also no point of failure.
- *Persistence:* Before being included to the block, the transactions are disseminated around every node and verified and reviewed by other nodes via a consensus mechanism.

## III. Overview of the architecture of blockchain:

- *Data layer:* The data is encrypted in this layer to use asymmetric cryptographic techniques as well as hash functions. Once the square measurements of blocks are validated, the data blocks connected in encrypted form within a blockchain
- *Network layer:* In peer-to-peer networks, there are virtual or physical connections between the nodes on a wireless or wired communication system. Blocks of transactions are validated regionally before being delivered the relevant overlaying nodes in the network.
- *Consensus layer:* This layer validates a transaction block's trustworthiness by employing algorithms of consensus such as proof of stake (PoS), proof of elapsed time and proof of work (PoW),
- *Incentive layer:* This layer is responsible for resolving digital currency concerns, developing incentive systems among miners, regulating transaction costs, and building acceptable procedures for producing cryptocurrencies and rewarding participants.
- *Service layer:* This layer provides services of blockchains for various industrial sectors.

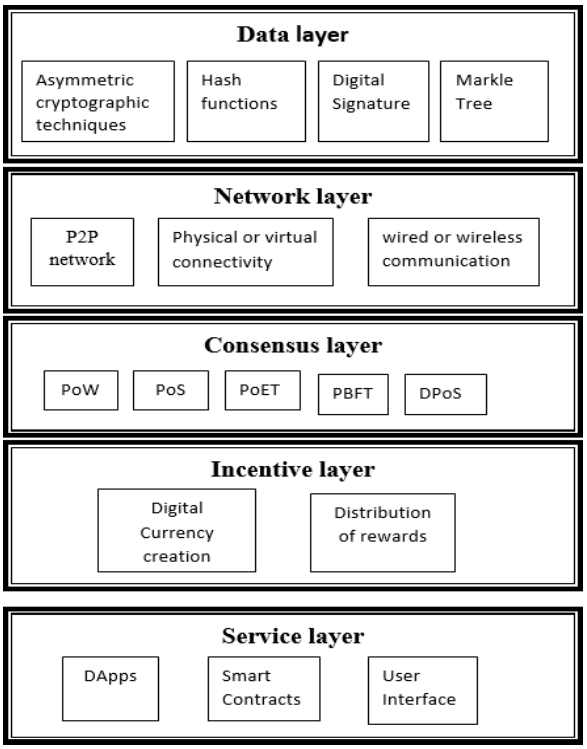


Figure 2: Blockchain architecture

## IV. Fundamental components of a blockchain

- *Cryptographically functions:* It is indeed a mathematical algorithm that converts arbitrary-sized data such as text, images, and files into a fixed and compacted bit string pattern. The hash value and perhaps even Message Digest is the output bit string that is distinctive for each input, as well as any modification in the data determination, indeed be represented within the hash value before consuming the Hash function. The authentication protocol generates a random number, known as a cryptographic nonce, which itself is added to encrypted data.
- *cryptography using Asymmetric-key*: This is also known as public cryptography since it employs two interrelated keys termed as the private and public keys. When the sender encrypts the text with the public key, the receiver decrypts it with the private key.
- *Transactions*: A transaction is a network data transmission that comprises information such as the sender's identity and a public key, including transaction inputs and outputs as well as a digital signature.
- *Ledgers:* A database platform stores a set of transactions that are synchronized and shared among several locations and users. Cryptographic techniques are used to store transactions and contracts in a decentralized manner. Once saved, the record could not be changed, which aids in the prevention of cyberattacks. It is transmitted in nature, having copies of records sent to several computers, making it impossible to modify a single record without affecting every one of the duplicates of the record.
- *Block*: Blocks are immutable digital records associated with transactions that comprise a blockchain. Based on blockchain implementation.

The following elements constitute the block header:

i. *Block version*: It is a group of block validation rules. ii.*Timestamp*: It contains the current approval time.

*iii. Merkle Tree: The Merkle root hash is actually the hash value of all transactions in the block.*

*iv. Target threshold*: It is a 256-bit unsigned integer.

*v. Nonce:* For each hash calculation, a 4-byte field is incremented from 0 to 1.

*vi. Parental control remains a 256-bit hash value that points to the block.*

The following are the components of block data:

I. *Transaction counter*: It keeps track of the entire amount of magnificently finalized transactions.

II. *Transaction data: This is kept within the arena as a result of transactions performed*.

## V. Consensus models

The consensus algorithm is a blockchain system that is critical in defining the effectiveness and safety of, and the algorithm category has a big influence on the system. Consensus algorithms employ various approaches, which are as follows:

- *Proof of Work (PoW):* Every node is chosen at random as from group of compute nodes, and the blocks of transactions is revealed. By altering the nonce value often, all network nodes compute its hash value of such block header. A typical rule of thumb is to choose a node with something like a hash value or even less equal to a certain target value. Following data confirmation, the block is added to the blockchain by all other users.

- *Proof of stake (PoS):* Total amount of cryptocurrency is called Stake, is the controlled by a blockchain network participant. A user with a larger Stake has a better probability of publishing the block.

- *Practical byzantine fault tolerance:* The primary node is chosen based on measurements and can handle up to one-third of malicious byzantine copies. Preparation, preparation, and commitment are the three steps of the selecting process.

- *Delegated proof of stake (DPoS):* Representatives as well as delegates selected by stakeholders for the purpose of constructing and validating blocks, who are rewarded and also have the identity ofpublishing node.

- *Round robin consensus model:* The publishing user's proof of identity is verified and added to the blockchain using this technique.

- *Proof of authority (identity) model:* Using this mechanism, the publishing user's evidence of identity is authenticated and posted to the blockchain.

• *Proof of elapsed time (PoET):* An arbitrary opportunity to think is supplied in the form of a signed certificate, which the client may publish alongside the block. Because this procedure is visible, a malicious user cannot wait a long period for blocks to be published.

## VI. Types of blockchain:

The blockchain allows the user to track quality on an individual basis. There are two types of blockchain:

1. In accordance with the authorization requirement
2. Depending on the type of data accessible

Depending on the type of knowledge available, blockchain can be divided into three types:

i. *Private blockchain*: it's supported access management, whenever users' ability to participate in network activities is restricted. This method only allows the identified node. The advantages include informal data handling, data redundancy, less transaction costs, and additional automatic agreement functionalities.

ii. *Public blockchain:* it's the open public network wherever each member will access and build transactions. Bitcoin is an important player because it employs localized Mechanisms to avoid the involvement of third parties. Participants rely on the capability of their processes to attest, store, and defend transactions within Data blocks.

iii. *Consortium blockchain:* It combines private and public blockchains. The blockchain of the semi-private with a small handler base, nonetheless it is presented to a wide range of enterprises.

The blockchain is classified into the following types based on the need for authorization:

i. *Permissionless blockchain:* To use the system during this technique, all participants must receive formal approval. By validating their role and identity, anyone can join a network. It allows specific participants to view the chosen records. The profile and permission-related activities are maintained by the access control layer.

ii. *Permissioned blockchain:* Any participant can perform transactions and validation on a permissionless blockchain. Participants in a permissionless network will grant you access to all information excluding private keys, which contain the process and the transaction details. No centralized authority to oversee all actions including ledger writing, protocol modifications, and network shutdown.

## VII. Blockchain's Importance in Healthcare

Blockchain technology's fundamental properties are useful to the healthcare sector. Among the several uses of the blockchain involved in the healthcare sector are:

• *Blockchain for medical record management*: The blockchain used to secure the patients' records and maintains doctor-patient confidentiality. All patient records have been recorded on the blockchain, and

patients have a choice over who gets access to their data. Because each patient is unique, treatment must be personalized to them based on individual health records; yet, there is no common treatment plan among them. Medical information is extremely delicate. and even tiny modifications as a consequence of the data in a life-threatening situation. A patient is assigned a unique ID, and the collected data is hashed.

• *Blockchain for medicinal research*: Blockchain implements a decentralized environment for storing researchers' data from all around the globe and may access the enormous insightful database with patients' consent, and data from studies that can be shared with other investigators while remaining safe. Blockchain technology can give evidence of its existence and allow anybody to confirm its legitimacy. When someone needs to change data, the majority of nodes must agree that the transaction is valid.

- *Blockchain for insurance claims:* The claim settlement process is completely independent and is protected by blockchain. Insurance firms and insurers can employ smart contracts, and blockchain can be used to avoid insurance fraud. Because blockchain data is immutable, insurers can easily access previous claims. When the conditions are met by using blockchain in a secure manner, the claim is settled electronically without the involvement of third parties.

- *Counterfeit drug blockchain*: Intellectual property theft in the pharmaceutical industry has become a big issue in developing nations. There is currently no data on their goods after the producers create it and distribute it to distributors. Pharmaceutical regulatory agencies make the drug untraceable. The adoption of blockchain technology inside this supply chain might lead to enhanced medicine traceability and security. Because of the immutability and timestamping of blockchain data, it is feasible to accurately trace a drug [8]. The concept of the blockchain might remain applied by establishing for a produced medicine using a hash value. The information about the medicine is contained with the hash value. As previously stated, the medicine flows through the supply chain after it is created. When the medicine goes from one entity to another, the data is transferred. This hash value comprises all of the drug's essential information. As previously stated, after the medicine is created, it flows through the supply chain. When the medication transfers from one entity to another, the data is saved on the blockchain, allowing it to be easily traced. Reliable blockchain companies can check the supply of medicines at any time. Because the medicine is traceable, if any difficulties are identified during the manufacturing process, the makers will withdraw their goods. For starters, it allows medications to be monitored all the long journey through the supply chain. Secondly, it keeps the imitation pharmaceuticals market; clinicians may access patients' data at any time, and so the specifics of the patient can reveal the medical record since their first hospitalization Blockchain technology has the ability to revolutionize how patients manage their healthcare requirements. By automating patient health records, blockchain has shown to be a lifesaver in effectively tackling the difficulty of mistakes.

- *Blockchain might help avert future pandemics.:* To solve COVID-19 concerns, the centers for Disease Control and Prevention ar working in accordance with the WHO and IBM It has started development on a project that will use blockchain technology to monitor, store, and distribute confidential material to health care institutions in real time.
- *Cost saving through Blockchain:* The healthcare industry that uses blockchain will undoubtedly save money through tokenization. Tokenization is a novel method that sent a digital asset. Blockchain can be used to eliminate unnecessary third-party customers. Pharmaceutical counterfeits can also be tracked.

## VIII. Proposed System Architecture

We proposed blockchain enabled decentralised distributed healthcare record system built in Ethereum platform. Ethereum node will store the healthcare record in the public blockchain whereas Ethereum client will store the hash key address value of the previous block and transaction history. The Dapps(decentralized application) is hosted in the Mist Browser.

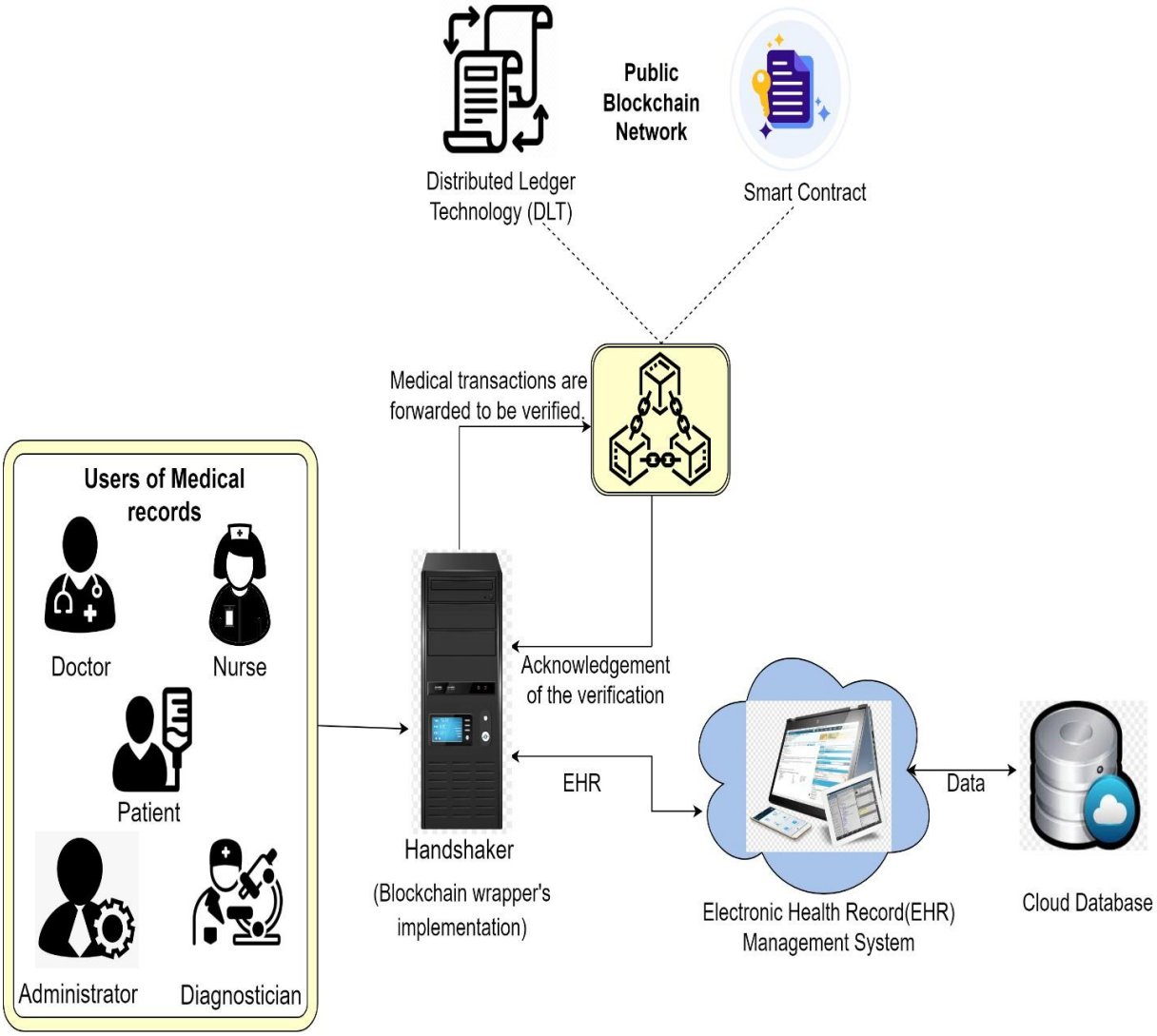


**Figure 3:** Blockchain-based EHR management system Architecture

Figure 2 depicts the architecture which includes four main parts: a user application, a blockchain handshaker, a cloud, and a public blockchain network. Every part is described below:

*8.1.* *User of Medical record*: A user application would be a software program that has two functions. For starters, it offers users application interfaces. There are several categories of users in our system, such as physicians, nurses, system administrators, pathologists, and so on. Each user type has a distinct role. As a result, the user application delivers several user interfaces depending on the user role. The user application connects people to the blockchain handshaker.

*8.2.* *Blockchain Handshaker:* The main component of our suggested architecture is the blockchain handshaker (BH). This component serves as a wrapper component for our proposed design, connecting the user application, Blockchain-based EHR system, and public blockchain network.

*8.3.* *Public Blockchain Network:* According to the agreement procedure, blockchain nodes seem to be the miners responsible for maintaining the blockchain up to date. Such that, a blockchain module receives the transactions and validates them using reasonable contracts. Once the transaction has been confirmed, the data is split into blocks and added to the distributed ledger. The broad public blockchain network answers to the transaction validator of the blockchain handshaker with a trueas well as false confirmation (TV).

*8.4. Cloud*: In our suggested design, the cloud delivers two services that are similar to typical cloud- based EHR administration systems. The very first service is EHR management system hosting and the data storage is the second service. A cloud serves as a database for all health records.

## IX. Conclusions and Future Work

Blockchain technology has seen significant and exponential growth in a variety of fields in recent decades. Obtaining consensus across all participating nodes on a single piece of data is a difficult task in such decentralized and distributed systems [9]. Blockchain technology will strike various application fields, unlocking the true potential, by implementing appropriate consensus mechanisms that satisfy the required features. Blockchain technology is important in healthcare data management because it addresses numerous issues such as counterfeit drug delivery, future pandemic solutions, and data securityof clinical data [10].

This research looked into recent developments in blockchain research in healthcare Blockchain innovation is a network of decentralized type and has significant potential for usage in healthcare due to the secrecy of the data collected and controlled.

This study sought to ascertain the present reification of blockchain research and its use in health care. Our findings indicate a rising interest in Blockchain based and its uses in healthcare.
According to recent trends in healthcare blockchain exploration is mostly utilized for health records, access control, and data interchange, nevertheless, it is seldom employed in other situations such as medication prescription management and supply chain management.
Aimed at additional study, blockchain is certainly relatively innovative in healthcare technology that allows us to discover and explore new applications. In summary, blockchain needs to be deployed in realistic and necessary scenarios.

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