# BLOCKCHAIN TECHNOLOGY AND ITS APPLICATION IN HEALTHCARE: A SURVEY

**Abstract**

Blockchain technology is a new development that is being used in a variety of industries, including the healthcare industry. Blockchain networks are utilized in the systems in healthcare to safely store and transfer patient data across hospitals, pharmaceutical firms, diagnostic centers, and healthcare providers. The capacity of Blockchain apps to precisely identify both critical and potentially hazardous faults in the medical industry is one of the significant benefits of using them in healthcare. The transparency, efficiency, and security of shared medical records throughout the healthcare network could, therefore, be improved by this technology. Blockchain technology can help medical organizations learn important lessons and ensure better analysis of patient information. This paper explores Blockchain technology and its benefits when used in healthcare. It provides the need for blockchain in healthcare and facilitates a road map of Blockchain in global healthcare. Additionally, it lists and discusses important Blockchain applications for the healthcare industry.

**Keywords:** Blockchain; Healthcare; Distributed Ledger; Transactions; Medical Records

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## I. INTRODUCTION

Blockchain is a decentralized, open-source digital ledger that keeps track of transactions on numerous computers and links them together to form an unchangeable chain of connected blocks. Due to the public recording of every transaction and the inability to make changes after the fact, this technology assures a high level of accountability. Blockchain distributes data across networks, improving security and lowering the danger of hacking, in contrast to conventional centralized databases. Additionally, Blockchain acts as an innovation platform, enabling the creation of innovative and cutting-edge business models that can compete with well-established firms. In essence, it offers a trustworthy framework for data integrity and expands business world opportunities [1-3].

Blockchain technology plays a crucial role in helping marketers maintain a comprehensive record of pharmaceutical products used in medicine. In the healthcare and pharmaceutical industries, Blockchain is a powerful tool for eliminating counterfeit medications by enabling the tracking of every medicine, making it possible to identify the source of falsification. Moreover, Blockchain ensures the confidentiality of patient records, providing an immutable and secure storage solution for medical histories. This decentralized network is implemented with standard hardware in hospitals, allowing researchers to compute estimates for various therapies, medicines, and remedies for a wide range of illnesses and disorders, thanks to the efficient resource management facilitated by Blockchain technology [4-5].

Blockchain operates as a distributed ledger network characterized by its immutability; once records are added, they cannot be deleted or modified without consensus. This is achieved through cryptographic hashes that connect newly added data blocks with existing ones. The decentralized nature of Blockchain ensures that data is not controlled by a central authority, providing accessibility and accountability to all network users and safeguarding against single-point attacks. This system enhances the management of health records and patient care, reducing redundant medical practices and monitoring, thereby saving time and resources for both healthcare practitioners and patients. Patients can also have greater control over their health information, tracking its usage by managing their medical records securely on the Blockchain network [6-7].

Researchers are able to utilize this technique to analyze the vast amounts of previously undisclosed information about a specific group of individuals, facilitating advancements in precision medicine for longitudinal research. This involves using Blockchain via wearable devices and the Internet of Things (IoT) for secure storage and updation of critical patient information like sugar and blood pressure levels. This system assists doctors in monitoring high-risk patients and provides timely advice and alerts to their caregivers and families in emergencies. Without depending on a single copy of the information, the decentralized nature of Blockchain assures the security of the data and guards it against attack [8-9]. The following research questions are examined in this paper:

- **RQ1:** To explore blockchain technology and the critical needs it has in the healthcare industry.
- **RQ2:** To identify how Blockchain technology could transform the global healthcare landscape.

 

- **RQ3:** To determine the “Roadmap" for applying blockchain technology to the provision of healthcare services.
- **RQ4:** To assess notable Blockchain applications in the healthcare industry.

1. **Blockchain Technology:** Blockchain is a powerful tool for protecting private data within a system since it is a decentralized node network. It makes it possible to communicate sensitive material privately and securely, and it offers the perfect way to group relevant papers in a safe spot. Additionally, by leveraging a single patient database, Blockchain streamlines the process of looking for applicants that fit particular trial criteria. A decentralized peer-to-peer (P2P) network comprising individual computers, or nodes, that manage, store, and record transactional or historical data can be used to define Blockchain [10–12]. By storing and transmitting information among all network participants while maintaining a continuous record of past and present events, Blockchain enables reliable collaboration. Through the capacity to combine several networks, this technology can provide light on the value of personalised care. Blockchain is well renowned for its immutability and security as a result. Blocks, nodes, and miners are the three basic principles at the core of the Blockchain world. Notably, Blockchain copies and distributes the Blockchain over a network of computers rather than centralizing its data in one place. A new block is added to the Blockchain on every computer connected to the network. Figure 1 depicts the fundamental stages involved in how Blockchain technology operates.

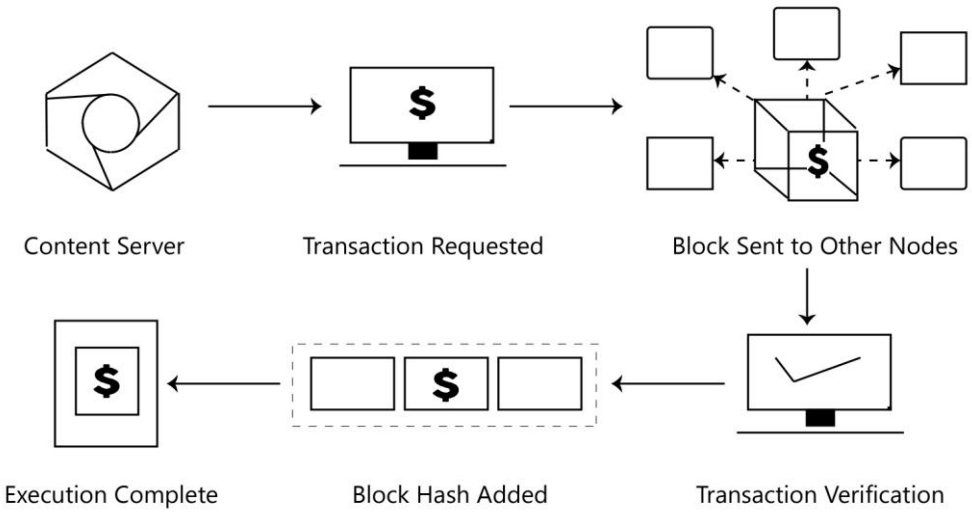


**Figure 1:** Working Steps of Blockchain Technology

Blockchain operates on the internet as a system that runs on a peer-to-peer (P2P) network of computers. All these computers adhere to the same protocol and maintain an identical copy of the transaction ledger. This setup enables peer-to-peer value transactions without the need for intermediaries, relying on machine consensus instead. There exist several types of Blockchain technologies, including public, private, hybrid, and consortium Blockchains. Each of these Blockchain networks comes with distinct advantages and disadvantages, which play a crucial role in determining their most suitable applications.

Bitcoin and other cryptocurrencies were first created using public blockchain, which is the oldest version of blockchain technology. It was crucial in making distributed ledger

 

technology (DLT) widespread. Public Blockchain addresses the limitations of centralization, including issues like security and transparency. DLT distributes data throughout a peer-to-peer (P2P) network as opposed to keeping it in a single area like centralized systems do. However, because of the decentralized nature, it requires a mechanism for authenticating data to maintain trust and accuracy. A private Blockchain describes the type of network that enables operation within a limited and controlled context, often within a closed network or under the authority of a single entity. It shares some likeness of public Blockchain networks regarding peer-to-peer connectivity and decentralization, but it typically has a much smaller scale and scope. In private Blockchains, the administrator is aware of the identity of all participating candidates from the outset. Unlike public Blockchain networks, private ones do not allow for anonymous participation, and they are often used to create permission-based solutions within specific organizations or closed networks. A blockchain that combines the qualities of both private and public blockchains is called a hybrid blockchain. It gives businesses the freedom to design a hybrid system that combines both public and private, permission-based and permission-free components. With this strategy, businesses may decide who has permission to view or interact with some Blockchain-stored data while simultaneously making some of it public and available to a wider audience. Businesses may take advantage of the best of both worlds by utilizing hybrid blockchains, which allow them to customize their Blockchain solutions to meet their unique requirements and use cases.

## II. NECESSITY OF BLOCKCHAIN IN HEALTHCARE

With an increase in the demand for high-quality healthcare services supported by cutting-edge technologies, the need for rapid development in the healthcare sector is more critical than ever. Blockchain technology has the potential to change the healthcare industry fundamentally. A more patient-centered strategy is being adopted by the industry as it changes, placing an emphasis on easily accessible services and always having the necessary healthcare resources available. Healthcare firms can give top-notch patient care and services thanks to blockchain, which has a number of advantages. Exchange of Health data, which is sometimes a cumbersome and continual procedure that adds to significant industrial costs, is one area where it can have a significant influence. This process can be streamlined and made simpler by blockchain, saving money. Blockchain technology also makes it possible for people to take part in health study programs, promoting improved public health research and data exchange. This, in turn, can lead to improved treatments for different communities. In contrast to traditional centralized databases used to manage healthcare systems and organizations, Blockchain's decentralized nature provides enhanced security and transparency, making it a promising solution for the healthcare industry's evolving needs [13-15].

Blockchain technology offers a solution to critical challenges in population health management, such as data protection, sharing, and interoperability. When properly implemented, Blockchain enhances data security and integrity, data exchange, and interoperability in a real-time environment. Particularly in fields like personalized medicine and wearables, where data protection is paramount, Blockchain provides a secure and user-friendly way for patients and medical professionals to record, transmit, and access data over networks, addressing safety concerns effectively [16-17].

 

## III. ROADMAP FOR BLOCKCHAIN IN HEALTHCARE SCENARIO

The integrated roadmap for the comprehensive evolution of Blockchain technology in healthcare services and the accompanying benefits it offers are shown in Figure 2. This includes benefits such as improved master patient indices, streamlined medical supply chain management, enhanced interoperability, and the efficient capture of both single and longitudinal patient records. These practices reflect the valuable impact of Blockchain in the healthcare sector [18,19]. The shared flow of the network, digital transactions, distributed ledger and data form the initial steps in the interactive process. These foundational elements empower Blockchain drivers to focus on enhancing healthcare services, making them innovative and happier than earlier [18,20].

Despite the fundamentals of blockchain technology are simple, they are constantly changing to meet the unique requirements and features of different businesses. Its separate framework allows for real-time updating of results and provides thorough monitoring. Blockchain has the potential to significantly reduce financial losses, prevent theft and unauthorized data transfers, address issues related to tampering with results and data breaches. It makes it easier to send permanently time-stamped clinical study reports and findings securely, which lowers the risk of fraud and mistakes during clinical trials. The healthcare industry bears a primary responsibility for adopting Blockchain technologies, given its potential to bring transformative benefits to the sector [21-23].

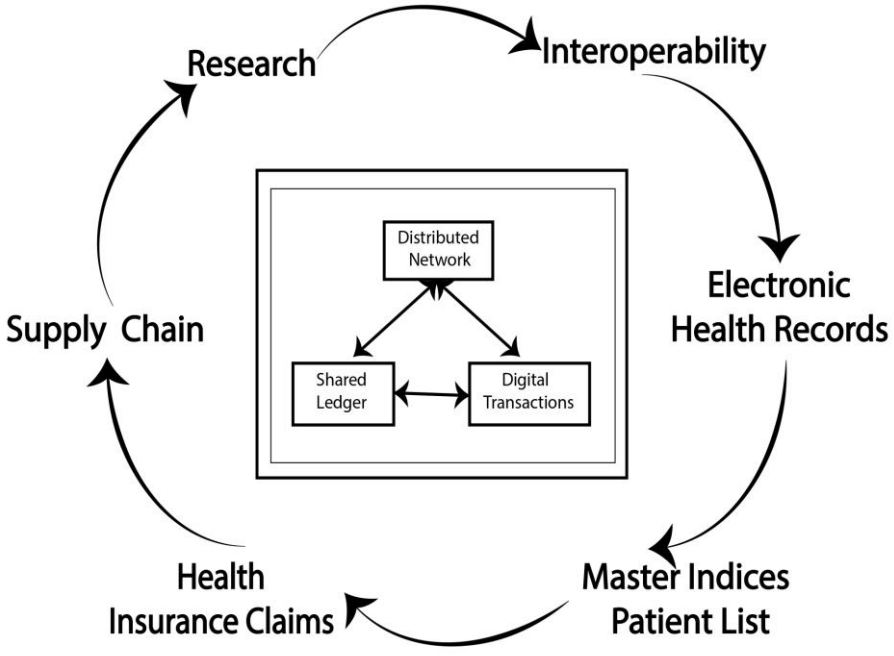


**Figure 2:** Roadmap for Blockchain in Healthcare

Blockchain is a technology that impacts virtually every industry, particularly in contexts where trust needs to be established among various parties and stakeholders. It can revolutionize the process of granting informed consent in healthcare, addressing the current fragmentation patients encounter when signing consent forms for appointments, clinical procedures, or medical tests. The sharing of clinical test data and the possible advantages for

 

test subjects are just two examples of Blockchain applications. Blockchain has the potential to be extremely useful in managing healthcare consents and streamlining information flow. Blockchain technology now allows patients to safely connect to various healthcare providers and immediately access their medical records, facilitating easy and effective data sharing in the healthcare industry [24–26].

Approved Blockchain inherent a closed network that grants access only to authorized system members. It is designed for secure information sharing and transactions within organizations and companies. Once a transaction is validated through consensus, it becomes a permanent record and is added as a new block to the existing Blockchain. In contrast, the internet allows anyone to create their own website, and users in a Blockchain network can communicate with each other without the need for authorization by generating their network address. This highlights the difference in accessibility and control between public internet usage and closed Blockchain networks [27,28].

A supply chain powered by Blockchain protects the security, reliability, and promptness of medical product deliveries, allowing producers to maintain the correct formulation in accordance with medical requirements. In the healthcare sector, Blockchain facilitates the secure charging of patient data, verification of treatment for the designated patient, and anonymous communication of routine data between patients and controllers. Recent advancements in medical science have demonstrated remarkable progress, and Blockchain technology, known for its distributed and transparent digital ledger, is making a significant impact on various markets and industries. In healthcare, where trust, security, confidentiality, and data interoperability are paramount, Blockchain offers innovative solutions to address these challenges in new ways. It promises to enhance the quality and reliability of healthcare services [29-31].

Blockchain stands out as a potential solution for health data protection due to its immutable, autonomous, and fully transparent nature. With Blockchain, individuals can keep their identity and medical records private while ensuring system stability. This groundbreaking technology can streamline the inefficient billing format by eliminating unnecessary back-end tools. It also empowers patients to upload their medical records and grants authorized parties access to view them. Blockchain technology has the potential to redefine how health information is shared by facilitating better efficiency, reliability, and security in handling electronic records of medical data. In essence, Blockchain is a DLT capable of recording vital transaction data [32-34].

## IV. APPLICATIONS IN HEALTHCARE

Blockchain is a cutting-edge technology with creative uses in the healthcare industry that makes it easier and more effective for network members and healthcare providers to share data. This makes it possible to create cutting-edge therapies that are also cost-effective for treating a variety of disorders, which promises to drive the healthcare industry's growth in the coming years. Recent revelations of Blockchain's potential in logistics demonstrate its advantages for the healthcare industry, which directly impacts quality of life and is a pioneer in digital transformation and innovation. Blockchain is simultaneously increasing popularity, especially in the financial industry, and it presents a wide range of important potential for the healthcare industry. These opportunities span science, logistics, and relationships between

 

patients and healthcare practitioners [35-37]. The most important Blockchain applications in healthcare are highlighted in Table 1.

**Table 1: Application Scenarios of Blockchain in Healthcare**

| Sl No. | Papers | Applications | Remarks |
|---|---|---|---|
| 1 | [38-41] | Storage of patient information | Ensures large amount of details of individual patients by storing it in format for every individual. |
| 2 | [44-45] | Specific analysis of procedural effects | Empowers pharmaceutical companies to provide tailored prescription drugs and services through real-time data collection thereby providing detailed analysis on particular procedures of medicines. |
| 3 | [46-50] | Validation purposes | Blockchain's algorithm-based validation and secure encryption hold the potential to revolutionize healthcare management, presenting opportunities for enhanced safety and cost-effectiveness both now and in the future. |
| 4 | [53-54] | Transparency and Safety | Ensures enhanced data exchange among healthcare providers for faster diagnostic accuracy. |
| 5 | [55-59] | Storage of health records | Consolidate patient information, by offering historical data while maintaining authenticity and privscy. |
| 6 | [60-63] | Clinical Tests | Ensure false detection in results and data research evidences. |
| 7 | [64-67] | Information Display | Enable traceability of medicines by displaying details of its origin to ensure quality specific medicines. |
| 8 | [68-72] | False Content Identification | Facilitate content verification, and access to real-time insurance records. |
| 9 | [73-76] | Overhead Expense Reduction | Reduces cost by streamlining health records and data security. |
| 10 | [77-80] | Monitoring of patients | Ensures better healthcare monitoring of patients and improved supply chain by by fostering transparency among patients. |
| 11 | [81-84] | Research Initiatives | Offers trustworthy sources via innovative research in clinical tests by initiating experiments on patients. |
| 12 | [85-88] | Finance management In hospitals | Streamlines bookkeeping by efficiently handling healthcare clinical records. |
| 13 | [89-92] | Safety Concerns | Increases overall safety via interoperability helping doctors to check authentic and unaltered reports. |
| 14 | [94-98] | Reduction in time and cost | Solves delay in information passing and ensures timely documentation. thereby revolutionizing healthcare. |

Blockchain is a decentralized ledger for documenting various transactions, offering accuracy and simplicity while saving time, effort, and costs in healthcare management. It addresses a significant challenge in the healthcare sector that accounts for the leakage of crucial information for illicit purposes. Blockchain applications can efficiently mitigate this issue. Providing users and database stakeholders with access to the most recent and authentic

 

patient records and evaluations is another crucial component [99,100]. Blockchain technology's future in healthcare is bright and promising since it tackles some of the most critical issues facing the sector. To ensure that everyone has access to the same information, it makes it possible to have a common platform for therapy providers and other services. Businesses can profit from using blockchain technology in the healthcare industry in a number of ways, including for medical tests, patient data, clinical research, the supply chain of medicines, and pharmaceutical product qualities [101-103].

## V. DISCUSSIONS

Blockchain technology enriches the integrity and transparency of medical tests by storing patients' data as digital thumbprints through intelligent contracts on the Blockchain. It offers numerous benefits in healthcare, including network infrastructure security, identity verification, authentication, and standardized access authorization for electronic health information. Blockchain is also applied to pharmaceutical supply chain monitoring and medication responsibility tracking. Individual patient data can be securely stored and analyzed, facilitating procedure validation.

The benefits of blockchain extend to patient monitoring, clinical trials, safety enhancement, information display, and increased transparency. It simplifies hospital financial reports, cutting down on the time and expense of data transformation. In data-centric environments, Blockchain generates hashes for patient health record blocks, allowing patients to share required data with third parties while maintaining confidentiality.

Blockchain technology addresses challenges in clinical trials, ensuring fairness, security, and transparency in data collection. It prevents data manipulation and benefits researchers and drug manufacturers by recording secure and unbiased clinical trial results. With key features of Blockchain technology like transparency in data and auditing with open management, resilience, and enhanced protection and privacy playing crucial roles in achieving healthcare standards, including pharmaceutical supply safety, this knowledge enhances patient care and facilitates post-market analysis for efficiency optimization.

## VI. FUTURE DIRECTIONS

The incorporation of Blockchain technology in healthcare presents specific challenges. Lack of experience is a significant problem because Blockchain applications are still in their infancy and need further investigation and study. Associations of physicians and regulatory agencies are also faced with this dilemma. However, the healthcare sector requires improvement, and Blockchain is likely to expand its applications in the future, enhancing treatment outcomes and process transparency.

Blockchain's core role in authenticating transactions and information transfers is crucial. In the near future, network members' consensus will enable authentication and registration of transactions through Blockchain. The foundation for a new era of data sharing for health concerns is provided via Blockchain technology, which provides strong security at the patient level using public and private key encryption.

Blockchain holds promise for addressing various healthcare challenges, including secure patient records, prevention of data breaches, improved interoperability, streamlined

 

procedures, better medication and prescription management, and enhanced monitoring of medical and supply chains. Regarding efficiency and creativity, blockchain in healthcare appears to have a very bright future.

## VII. CONCLUSIONS

Blockchain technology, with its encryption and decentralization features, has promising applications in healthcare. It enhances electronic medical record security, supports health data monetization, increases healthcare organization interoperability and fights fake medicine. Key areas where Blockchain can transform healthcare include digital contracts via smart contracts, reducing costs by eliminating intermediaries. Its potential depends on deploying complementary cutting-edge technologies, enabling applications in clinical trials, healthcare insurance, system tracking, and pharmaceutical tracing. Services at hospitals can be streamlined and enhance patient history management with Blockchain, accelerating clinical processes and improving healthcare services. In essence, Blockchain has the potential to revolutionize how patients and physicians interact with clinical records, ultimately enhancing healthcare delivery.

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