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The important aspects of Blockchain Technology and Big Data in Healthcare System

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Abstract

In the 21st Century, the healthcare industry has progressed a lot. Scientists and researchers are finding an effective way to manage the issues related to healthcare management. The patient record is vital to investigating the disease promptly and providing effective treatment. The digital health system facilitates healthcare practitioners to easily access patient records through the Internet. The privacy and security of patient data is important to build the trust. Big Data and Blockchain provide a new way to deal with data and privacy issues. Big data management is a way to handle massive volumes of data. The patient data is generated in huge volumes and contains a variety of data. Big Data provides a great way to deal with huge and heterogeneous data to deal with that much amount of data. On the other hand, blockchain is a new concept essential to handle privacy issues related to patient data. The paper discusses different aspects of blockchain and big data management in healthcare.

Keywords: Blockchain, Electronic Health Records, Patient Centric Electronic Health Records, Big Data

INTRODUCTION

The Healthcare industry has gotten much attention from scientists and researchers over the past few years. The research on the healthcare sector provides an excellent solution for the problems related to proper health management. Recent advancements in the health industry such as Big Data, Machine Learning, Deep Learning, Computer Vision, Medical Imaging, Wearable Body Sensor Networks (WBSNs), and Blockchain technology play a vital role in solving the real-time problems of the health industry. The main people in the health industry are the healthcare providers and patients. Proper health management facilities help solve many issues related to patient healthcare. Big Data and Blockchain are among the most emerging fields that help the medical industry in various ways. Blockchain (Vazirani et al., 2019) Technology helps doctors access patients' medical records from different sources. This allows doctors to diagnose the problem and provide an effective treatment quickly. Blockchain technology uses distributed ledger technology. It provides security and privacy as the key features. The secure transactional records are managed through blockchain using distributed ledger technology (Ghosh et al., 2023; Shinde et al., 2024). The cryptographic approach in blockchain technology makes the data sharing secure across the network. Information security is an important

component that must be maintained properly while accessing information. In healthcare the data of the patient is secure. Maintaining security blockchain technology helps to maintain security and avoid the breach of sensitive data (Saranya & Murugan, 2023). Data is an essential asset for human life in different fields such as education, agriculture, health, management science, and other areas of life. Data is crucial and critical for business, social, and economic purposes. A massive volume of data is known as "Big Data." Initially, the term big data was used in the 1997s. Data has been an essential part of human life since the human evolutionary ages. The term "big data" describes vast amounts of data from one or more sources that are stored in one place. High volume, velocity, validity, and variety of information are the main focuses of big data. To aid in crucial decision-making, this data can also be shared, reduced, and analyzed (Zhang et al., 2017). In the last ten years, big data and the Internet of Things have gained importance as digital means for data processing, access, storage, and sensing. A vast volume of data is generated because of the innovation of small gadgets.

Due to important sources of data generation, the volume of data has suddenly expanded. Since data access, both computing power and data storage capacity have improved. The amount of data generated by various sources, including the web, sensor devices, and social media, is causing a rapid change in the methods of storing, analyzing, and accessing data (Agbo et al., 2019). Because of this, different organizations have varied ways of handling large data processing, access, use, and storage. Big data concepts of today include the methods and tools needed to handle enormous volumes of data (Sott et al., 2020). Because of this, the skilled professional and tech person needed to handle this massive volume of data. For future decision-making, new technological developments are required to handle the enormous volume of data. There are numerous established paradigms for handling data analytics in big data. Due to the growing interest in blockchain technology and its widespread acceptance across many industries and organizations, the healthcare sector has become a major area where numerous use cases for its application have been established. However, there is a lot of misinformation, speculative ideas, and uncertainty regarding the potential usefulness of blockchain in the healthcare industry because it is a relatively new technology and has been the subject of a lot of hype in the press and other publications (opinion pieces, commentaries, blog posts, interviews, etc.). The remarkable feature of blockchains is their capacity to eliminate the necessity for a trusted intermediary in distributed applications, effectively circumventing the single point of failure issue that a central authority usually presents in transactions among multiple parties within a decentralized framework.

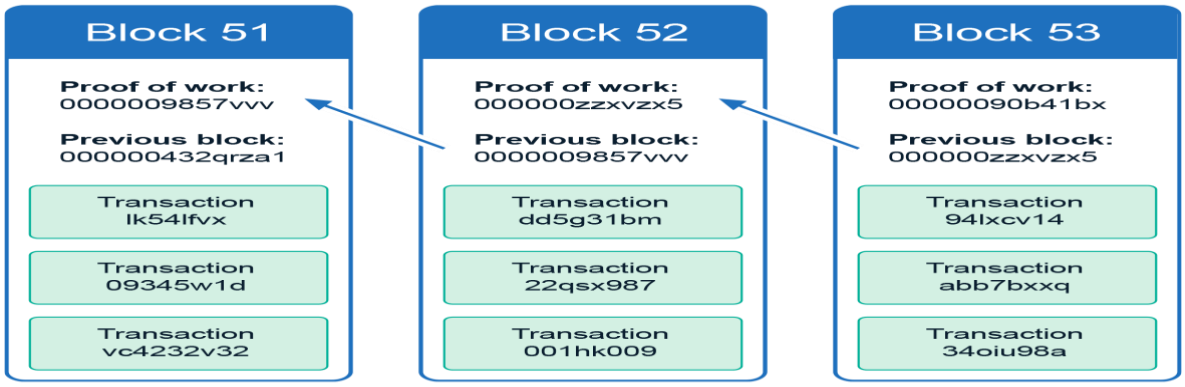

Figure 1.
Blockchain Structure

Healthcare System and Data Management

Enhancing security, user experience, and other facets of the medical sector are the primary advantages that technological advancements are providing. Electronic Medical Record (EMR) and Electronic Health Record (EHR) systems provide these advantages. They still have some problems, though, with data integrity, user ownership, and the security of medical records. The application of cutting-edge technology, like blockchain, maybe the answer to these problems (Shahnaz et al., 2019). Patient health status updates with efficient records management are crucial to healthcare record management. Adopting electronic health records (EHR) is now one of the most powerful associate technologies in healthcare. Patient health status record management is now a crucial part of technology-based management to make efficient decision-making for the treatment of the disease (Jamoom et al., 2016). Personal health record (PHR) management is now one of the key industries these days and due to that, the healthcare industry has many challenges in health record management. There are many barriers due to huge data records, including distribution and limitation of health record integration from different perspectives (Hölbl et al., 2018). The data can be generated from different domains that are challenging parts of electronic record management for health care systems. The other challenges which can arise are security issues such as confidentiality and privacy. The repository where patient health status and record of years are stored for future health status recovery. However, this is sensitive data and is not shared with providers and patients. This is important because the sharing of data creates many technical problems due to complex structures (Roehrs et al., 2019). There are a few important barriers that often occur due to two important factors:

- Common health data standards
- Large data integration

The repetition of all patient health diagnoses such as laboratory tests, diagnostics, unraveling treatment, and some ridiculous examinations causes a waste of wealth and time. It is well known that time is an essential factor for patient healthcare. Proper record management is part of patient diagnostics, which keeps track of future treatment (Sharma & Balamurugan, 2020). The patient has to re-treat in all tests and checkups due to a lack of electronic record management. However, developing countries have a very effective record of patients, which helps maintain a patient history and be integrated through the country's healthcare laboratories. The integration is only for the organizational levels, not with the patient, due to some physiological and privacy issues(Chukwu & Garg, 2020). The organizations mostly know the patient's health status, which is relevant to the current examination, but they do not have to get the patient's previous history checkups. The patient's daily nutrition wellness data, the data recorded and collected from wearables or routine checkups monitoring at home. Health providers are not so connected or integrated with the organization that deals with daily routine checkups and diagnoses on the patient.

Blockchain Technology in Healthcare

Blockchain technology is a promising aspect of the computer domain widely used to address the barriers with distributed PHRs. Security and privacy are the key factors in the health sector that can be maintained using blockchain technology (Uppal et al., 2023). Due to the rise in employing IoT in every field, data sharing poses different security threats. Blockchain technology helps maintain greater security by transferring data securely (Ali et al., 2023). The various fields of life now implement blockchain

technology due to a unique method of data distribution addressing issues. Initially, it was used to address virtual financial currencies to trade electronically. These days blockchain is widely used in many healthcare systems all over the world. It can handle large data records integration and distribution to a wide range. It also ensures the privacy and security of the patient's health records. Few effective approaches are introduced to deal with integration and privacy issues such as a distributed ledger of health records(Kuo et al., 2017) and useful tools for patient health record privacy. Blockchain technology is a digital record ledger that is widely used for recording and sharing information over different channels (Hussien et al., 2019). The entries in the digital ledger are clear and transparent for the user which can be viewed over all history. An important part of blockchain technology is cryptology which is the substitution of third-party intermediaries as trust keepers. At this point each participant runs an algorithm which is usually very complex to run, to certify and verify all entries when they want to do some operations on it.

It is an important aspect of technology due to some trustable operations for both clients as well as users/professionals. It is due to p2p network providers which ensures the privacy of the user contents. The key components of blockchain technology include distributed digital ledger, public key cryptography, and consensus mechanism. These three components can coordinate, share, and communicate over distributed heterogeneous devices that are maintained by different vendors or entities. Blockchain provides a decentralized mechanism of data sharing which is the best way for each user to achieve appropriate purpose. The system's state is reflected in the machine, replicated through the consensus mechanism logic and the peer-to-peer network to all users within the network. The replication of records is stored in the context of blockchain, referred to as a digital ledger and collectively used by the members of the network. For the creation of a public address, the public key is used with a hash function for sending and receiving important assists (Koshechkin et al., 2018). The digital transaction is only possible to sign in by using the private key for assurance of the valid user transaction which is performed confidentially. Every block in the transaction should include a single transaction, the signatures of the block validators, and a reference to the previous block, along with the corresponding block headers.

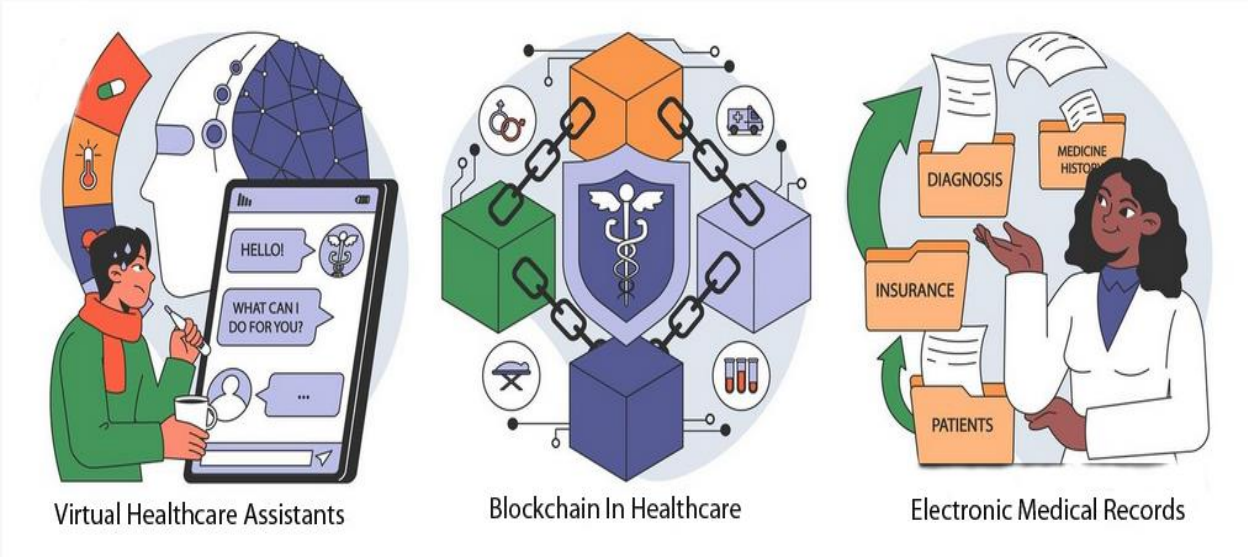

Figure 2.
Blockchain in Healthcare

Electronic Health Record

Electronic health record (EHR): The electronic representation of a patient's medical history, encompassing highly sensitive personal information regarding their background, diagnosis, and treatment journey. Common examples of additional EHR data include laboratory test results, billing and accounts, and appointments. Despite ongoing issues with interoperability and privacy, EHRs are currently seen as essential components of the healthcare sector (Han et al., 2022). Electronic Health Records (EHR) refer to platforms utilized for organizing patients' medical backgrounds and treatment details alongside lab findings and other health data points to facilitate access, to patient records among healthcare professionals while boosting collaboration and enhancing the quality of healthcare services overall. Furthermore, recognized for their ability to support decision-making based on data and provide long-term insights into patient health patterns crucial for preventive healthcare and precision medicine (Han et al., 2022).

An electronic health record (EHR) usually contains information, about patients like their details and medical background including allergies and vaccination history along with test results and X-ray images. Moreover, EHR systems aid in interoperability. Enabling smooth data sharing among healthcare platforms. However, achieving this objective is difficult due to differences in standards and privacy issues related to data (Pilares et al., 2022). The integration of EHR systems in healthcare has led to results like decreasing mistakes in treatment procedures and enhancing the well-being of patients while also helping healthcare professionals follow evidence-based guidelines more effectively. Nonetheless, challenges exist for EHR adoption such as the expenses associated with implementation and concerns about usability as well as the protection of sensitive patient information (Shuaib et al., 2021).

Figure 3.
Electronic Health Records (EHRs)

Patient-centric electronic health records

The patient-centric healthcare model is a revolutionary paradigm that turns the spotlight on the patients to make them central in the discourse surrounding healthcare provision. It focuses on personalized care, accessibility, and control over personal health data. Second, forcing clinical data and health information exchanges, Blockchain technology has inherent high security, transparency, and

decentralization, which is an ideal solution to achieve these objectives. Creating a blockchain-based medical record system that can be combined with current electronic medical records software might provide a completely integrated, single view of a patient's data, which would address this issue. A hash function, which is a condensed string of letters and numbers, is created from every new item you submit to the blockchain, including prescriptions, test results, and doctor's notes. And that's because the blockchain never contains actual patient data. Possess their hash algorithm, which is distinct and requires consent from the data owner in this example, the patient to decrypt.

Figure 4.
Patient-Centric Electronic Health Records

Importance of Blockchain in Patient-Centric Healthcare:

a) Decreased Data Breach and Privacy Concerns

Blockchain utilizes cryptographic processes to protect health records, making sure patient data is immutable and safeguarded against any unauthorized access.

b) Decentralized and Patient-centric

Healthcare based on decentralized principles can be achieved, allowing for data ownership and control by the users themselves.

c) Interoperability

Blockchain allows for secure sharing of health information among various healthcare providers, minimizing duplication of tests and improving coordinated care.

d) Transparency and Trust

Each data transaction being stored on the blockchain allows patients and healthcare providers to track the history of medical interactions, promoting trust and accountability.

e) Better Accessibility

Patients can access their health records from anywhere with an active internet connection, allowing for timely care provision, especially during emergencies or when traveling.

f) Prevention of Fraud

With a transparent and immutable record of healthcare transactions, blockchain helps eliminate problems such as insurance fraud and prescription forgery.

Use Cases of Blockchain in Patient-Centric Healthcare:

- **Personal Health Records (PHR)**

Health patients can be saved securely on the blockchain and can also hold wearables, genetic data, and lab data in one common format.

- **Medication Adherence Monitoring**

Blockchain-based systems could securely store and track medication adherence data to ensure that patients comply with prescribed treatment plans.

- **Clinical trials**

Patients can participate in clinical trials without concern for data misuse Blockchain also makes consent and sensitive information transactions transparent.

- **Telemedicine**

Blockchain can improve the security of virtual consultations by ensuring patient data stays confidential during remote healthcare appointments.

CONCLUSION

Big Data and Blockchain together play a very important role in providing a proper healthcare platform for healthcare practitioners. The health industry can improve beyond expectations with the help of proper utilization of technology. It is essential to address all the data storage and privacy issues. Implementing these technologies will provide a new way to deal with many real-time problems in the health industry.

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