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Block chain technology in healthcare: challenges and opportunities

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Abstract

Patients and healthcare practitioners are faced with the challenge of accessing, managing, integrating, and sharing health records securely. Patients should be able to manage their health records anywhere in the world, keep track of medical background, give access to data, and share those with any healthcare professional securely. Direct access to data for patients and a more robust data-sharing infrastructure could better prepare the healthcare system to manage public health threats during the emergence of deadly disease outbreak such as COVID-19. Current technologies in use by the healthcare industry do not adequately address these requirements due to limitations related to privacy, security, and full ecosystem interoperability. This paper conducted a literature review to find out the pivotal roles blockchain technology play in solving some of the most critical and challenging issues facing the healthcare industry. This paper identifies challenges and opportunities for implementing blockchain technology in healthcare and summarizes health-related blockchain products and key players offering solutions across different applications. In doing this, our research extends and complements existing blockchain research in healthcare.

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Introduction

A significant challenge for the healthcare industry is proper management and safe retrieval of the massive amount of personal health data generates by the normal activities of conducting business and providing services. Healthcare monitoring technologies, including wearables, also generate massive amounts of personal health data. Health data is mostly inaccessible, non-standardized across systems, and challenging to understand, use, and share. They are pulled from diverse sources and are stored in centralized IT systems that make managing and sharing a challenging task. Requesting, sending, receiving, and compiling patient data are time-consuming and require excessive resources [1]. Proper management and safe retrieval of these data enable healthcare systems to create holistic views of patients, improve the quality of care and treatments, enhance communication, and improve health outcomes [2].

Another problem facing the healthcare industry is interoperability, inaccessible medical records, and lack of comprehensive and secure population health data. The recent Public health crises further highlight the lack

of interoperability in the current healthcare system. Finally, the security of healthcare data is a significant issue for the healthcare industry. Many healthcare organizations store valuable health information in a central location in an aging legacy IT infrastructure that is a prime target for ransomware and other cyber attacks [3].

There has been a recent push towards patient-driven interoperability, in which health data exchange is patient-driven [4]. However, the healthcare industry is still in the beginning stages of developing infrastructure, computer programs, and strategic methods that can bring together the different types of data available to them on a reliable, secure, and consistent basis [5]. Existing healthcare data systems have several limitations, including patients' privacy, data integrity, quality, and accuracy. The healthcare industry is looking for opportunities provided by different technologies to resolve some of these critical challenges. As such, a novel technology that could facilitate the shift to patient-centered interoperability is in high demand. Blockchain technology can help solve some of healthcare's interoperability challenges and can play a critical role in putting patients at the center of the ecosystem [6]. Research about blockchain and healthcare is currently limited [7]. Current literature provides little overview of applications that have been developed, tested, and/or deployed. As blockchain applications become more mainstream, it is essential to examine whether the blockchain-enabled healthcare system improves health outcomes and lowers chronic disease risk within our communities.

Blockchain technology

Blockchain technology is one of the most important innovations of this century. It not only provides operational and regulatory verification efficiencies; it also enhances tractability and visibility throughout the supply chain of many industries [8]. Distributed ledger technology (DLT), known as 'blockchain', has captured the imaginations and wallets of the financial services institutions [9]. A blockchain is a decentralized, continuously growing list of records, called 'blocks', that are linked together in the chain through a process called mining. This process turns pending transactions into a mathematical puzzle. Miners (people) solve the puzzle using computer systems and produce what is called a hash – a sequence of letters and numbers unique to the block [10]. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. It also contains information from all previous blocks and transactions to create a network or chain. If the data inside any one of the blocks changes, it sets up a chain reaction that could freeze up the whole blockchain. Once the blockchain processes the information, every computer in the network locks in at the same time, creating a permanent, immutable digital record. Each blockchain system determines who can add new blocks to the chain and how the procedure is done [11]. The unique advantages of blockchain are that it allows sharing data and transactions on an immutable P2P network to enhance transparency, security [12]. Blockchain has been largely used for cryptocurrency and financial transactions. However, other industries, including entertainment, manufacturing, and healthcare, are adopting blockchain technology to leverage its benefits of enhanced security as well as privacy [13].

Blockchain will help solve some of the healthcare's interoperability challenges and can play a critical role in putting patients at the center of the ecosystem. It enhances security, privacy, interoperability, and can put patients at the center of the ecosystem. blockchain can be applied to the accessing and sharing of patient medical records, mobile applications and remote monitoring, and medical data management system that allows patients to retain ownership over their records. Blockchain application in healthcare and discuss how technology can address some of the challenges and issues facing the industry.

Critical challenges and blockchain solutions

The healthcare industry is implementing strategies and tactics to address the growth of medical and pharmaceutical costs and improve the quality of care. Faced with critical challenges, issues, and opportunities provided by technology, the healthcare industry is changing rapidly in several ways. First, it is no longer the alliance between big pharma, big government, and trained medical professionals. Tech giants are getting into the industry intending to implement strategies and tactics to address the growth of medical and pharmaceutical costs and to impact access and quality of care. Consumer health is a growing target of these companies' massive R&D investments. Second, the existing healthcare system takes care of us after we get sick, treating symptoms, not preventing root causes. COVID-19 may be speeding up the trend of continuous healthcare, where richly layered data-driven decisions are replacing what we have today. Lastly, wearables introduced by Apple, Google, Amazon, and other tech companies continuously monitor individual health

parameters, including body temperature, heart rate, respiratory sounds, heart rate variability, walking steps, 24/7 by sensors. The data and health parameters gathered by these devices could later be analyzed, accounting for what you eat, how you sleep, and any set of behaviors. Software created by these companies aimed to improve patients' lives holistically, monitoring how we live, our daily routines, and preventive guidance informed by digital health research. In the latest COVID-driven initiative, Apple and Google will be launching a comprehensive Bluetooth-based opt-in contact tracing technology. The plan is to implement complete contact tracing through voluntarily shared mass consumer data, tracking individual movements, and precise interactions between followed users and their health data. Any technology approach to improving healthcare must consider actual needs from the diverse perspectives of consumers, patients, providers, and regulators and be responsive to the unique challenges faced in healthcare compared to other sectors of the economy.

Data collection and storage

Healthcare monitoring technologies, including wearables, generate massive amounts of personal health data. Proper management and safe retrieval of these data are crucial for data-driven decisions in our healthcare system. Our existing healthcare system also generates data by the normal activities of conducting business and providing services. Patients interact with numbers of health care providers through the course of their lives, leaving data scattered across a provider's system. Providers often retain primary data stewardship and create a fragmented data trail and decaying ease of access for patients. Healthcare data is characterized by a large volume, heterogeneity, and speed. They are non-uniform, have many variables, and need real-time data analysis. This data is mostly inaccessible, non-standardized across systems, and challenging to understand, use, and share.

Current status of healthcare record-keeping and medical history

The following are characteristics of the current healthcare records keeping and data collection systems.

- It relies on the interaction between patient and physician
- It keeps failing to take advantage of the data
- It creates a long and tedious process of getting healthcare
- Critical patient information is scattered all over the systems
- It lacks critical data availability, therefore, many healthcare systems fail to provide the necessary treatment to the patients
- It negatively impacts management system as many players are not equipped with the right information for a smooth process
- It provides poor healthcare data security and reliability.

The healthcare industry is very inefficient, where most medical records are still stored on paper and distributed locations. They cannot be used to coordinate care, measure quality, or reduce medical errors. Healthcare data are digitally collected in diverse points. It is important to extract the best benefits out of this healthcare data without complicating the processes. A crucial challenge facing the healthcare industry is the ability to record and store information easily and economically and share it securely across disparate applications and systems. The portability of data and uniform compatibility while working across diverse systems is also essential.

Blockchain solutions for healthcare record keeping

Blockchain technology is suitable for any kind of digital data where authentication and consensus about data integrity are important, and where shared write access for several parties is necessary. Blockchain can be used to keep important medical data safe and secure. Blockchain can provide a solution to recordkeeping problems in the healthcare industry, and it is particularly useful for recording continuous and steady growth of transactions. Blockchain is more appropriate for an open consumer transaction environment where the older information is less important and where data growth is continuous and steady. Blockchain technology is being considered for securing DNA data, personal information, healthcare records, and essential medical history information. Healthcare providers can use blockchain to store details about patients' records where patients and doctors can directly check those records through the network, anytime, anywhere.

Blockchain enables uniform portability and multi-faceted protection system across different phases. It enables health providers to create an integrated health records system where patients are at the center, owning the private key to their data. Patients control who can access or use their data. The blockchain-powered

integrated system helps in the reconciliation of records and activities as well as help in curbing fraud. The system will also help patients to access and manage their health records anywhere in the world; share those records with any healthcare professional securely; and keep track of their medical background such as allergies, chronic diseases, and vaccines. A recent study proposed a blockchain-based data preservation system for medical data that can provide a reliable storage solution to ensure the primitiveness and verifiability of stored data while preserving privacy for users. The prosed data system enables users to preserve important data in perpetuity. The originality of the data can be verified if tampering is suspected . Another study proposed a blockchain-based secure and privacy-preserving personal health information sharing system for diagnosis improvements in e-Health systems. Due to its advantages of immutability, blockchain can help to improve the accuracy of diagnosis, where security and privacy preservation are critical issues in the systems.

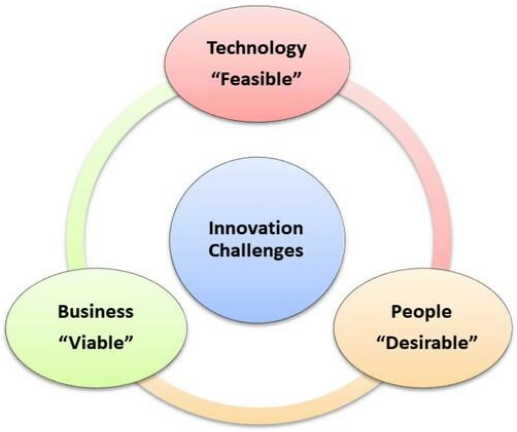
Blockchain solutions for pharmaceuticals

Drug traceability

Another major problem facing the healthcare industry is the drug counterfeit problem, where over 15% of drugs sold in developing countries are counterfeit. Pharmaceutical companies lose about $200 billion annually due to counterfeiting. Blockchain can solve the counterfeit drug problem by providing visibility, security, and drug traceability. The technology uses features like proof of authenticity and point-by-point tracking possibilities to curb the counterfeit problem, ensuring that once a drug is produced that it is genuine. The user can verify the authenticity of the drugs before purchasing them. Blockchain not only can be used to track the drugs from its manufacturing until its delivery to the patient but also it can record a drug effect on patient to a database after the usage for future statistics.

Clinical trials

Clinical trials, a method of testing a new drug and its effectiveness in a controlled environment, produce tons of data. The process is expensive, takes a few years to complete, and not without fraud. It is crucial to have a transparent solution that lets anyone review the clinical reports and ensure that the results of the trial are not tampered with. Blockchain can be a great technology to facilitate clinical trials by providing data integrity, and the authenticity of the documents needs to be verified. The distributed network ensures that no data can be modified without authorized access.



Implementation challenges and barriers to adoption

Blockchain advantages were flexible, adaptable, agile, and secure infrastructure with high performance and low latency. The distributed network also provides a unified and secured view and exchange of electronic health records. Disadvantages were cost, complexity, hype, uncertainty about this technology, and patients' lack of awareness of this new technology. Other studies identified 'lack of evaluation in a real-world setting', in addition to legal, social, and technological limitations among barriers of the adoption. Another study researched the potential challenges and proposed solutions for adopting blockchain technology in biomedical/health care domains.

Blockchain is still a very new technology for many industries. As such, numerous obstacles stand in the way of its speedy deployment. Enterprises are not quite sure how to scale blockchain technology. Scholars and experts are quick to point out that the new blockchain-based technology is not a cure-all for what ails many industries. For blockchain technology to work effectively, many barriers – technological, governance, organizational, and even societal will have to fall. They believe blockchain is not a 'disruptive' technology; rather, it is a foundational technology – it has the potential to create new foundations for our economic and social systems. Whether considered as 'revolutionary' or 'disruptive', blockchain approaches must be responsive to the unique healthcare needs from the diverse perspectives of consumers, patients, providers, and regulators.

Conclusion

Blockchain technology as a paradigm changer with its innovative approach to decentralized management, enhanced security, and immutable audit trail. The paper also explored the different blockchain use cases and applications in healthcare. The result indicates that

blockchain can improve access control, interoperability, provenance, and data integrity in healthcare. Blockchain's distributed nature, transparent information structure, and immutable records keeping and stored across all participating users can help reduce the cost of these operations. The paper concluded that the technology could be used to securely coordinate and combine information from multiple providers, improve patient engagement, help to ensure availability of patient information, allow direct and secure communication between patients and providers, and encourage family health management. Additionally, ledger technology can manage the medicine supply chain and help healthcare researchers unlock genetic code.

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