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# Fortified Chain a Blockchain-Based Framework for Security and Privacy Assured Internet of Medical Things

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**ABSTRACT:** Data in healthcare domain is highly sensitive in nature. Besides, there is need for maintaining integrity of such data. Blockchain technology has emerged to solve the problem of data integrity and non-repudiation with immutable storage in distributed repository. Thus secure data storage and retrieval in cloud environments is made possible using blockchain implementation. There are many existing healthcare systems with blockchain integration found in the literature. However, there is need for a system that supports complete set of operations that are governed by smart contracts. Another important consideration is that end users should be able to operate healthcare system without the need for knowledge of blockchain technology. Towards this end, in this paper, we proposed a Blockchain based secure healthcare data storage and retrieval system known as Health Block for cloud computing environments. We defined smart contract with underlying structures and functions using Solidity language for Ethereum blockchain platform. We also proposed and implemented an algorithm known as Healthcare Transactions over Blockchain (HToB).

**KEYWORDS:** Internet Of Medical Things, Public Cloud, Medical Health Records, Cryptography, Search Over Encrypted Data.

## I. INTRODUCTION

Securely recovering and correctly managing the amount of individual health data created by delivering service operations and normal business is a major challenge for the healthcare industry. Most of the health data is not easy to access or standardized across systems, and is difficult to interchange, utilize, and understand. They are compiled from several locations and stored in centralized information technology systems, making them challenging to share and administer. Time and energy are required to synthesize, receive, send, and request medical information. Safe data retrieval and management enable healthcare systems to improve health outcomes, communication, treatment quality, and patient views in their entirety.

Legacy systems are notorious for being incompatible with newer technologies and for only being able to communicate with other healthcare and medical systems on a limited scale. Data shows various advantages of integrating these networks for better and linked healthcare; however, researchers in health informatics should consider interconnection across different companies. One of the biggest challenges in this area is multi-organizational data sharing, which requires healthcare providers to make their patients' medical records freely accessible to other organizations, including research or physician institutions.

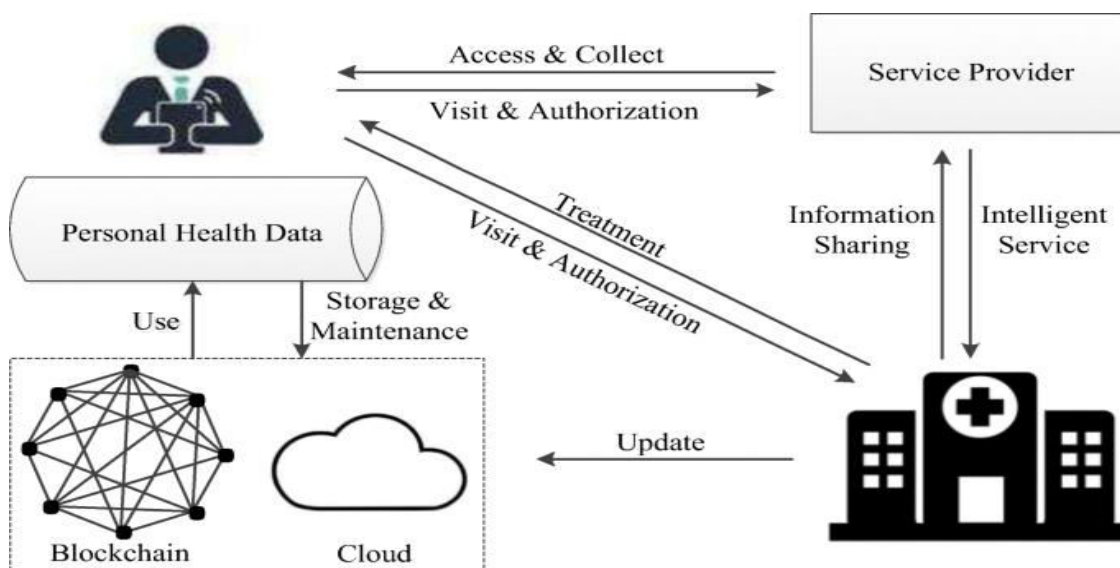


Fig 1: Blockchain-Based Medical Records Secure Storage

Given the present state of affairs, comprehensive reform of the universal healthcare system is necessary. Historically, medical professionals have handled their evaluations, documentation, and reports on patients and any necessary adjustments to their treatments. With longer life expectancies and a growing world population, a more powerful tool is required for population control. The Internet of Things (IoT) or other decentralized platforms may be employed in this context for achieving dispersed coverage. In light of this, healthcare systems are a crucial IoT application.

Internet of Medical Things (IoMT) is the kind of IoT that is used in the healthcare industry. IoMTs are the wave of the future in healthcare since they will enable the connectivity and remote monitoring of all medical equipment. Due to these developments, healthcare may now be provided more rapidly and at a lower cost. Medical workers (nurses, physicians, etc.), medical data servers, and medical sensor equipment make up the bulk of an IoMT system that provides remote healthcare.

There is a long way to go before IoMT can be utilized widely. Most implanted and wearable medical sensor devices lack the computational power and battery life to make complex encryption schemes practical. This means that wireless data transport in the IoMT is open to external attacks. Due to the sensitive nature of patient information included in medical records, it is important to realize that only authorized parties have access to these records. Poor IoMT interoperability is also a problem because of the wide range of medical sensor devices that are available and the diversity of IoMT networks.

## II. RELATED WORK

There are a number of different approaches in which blockchain technology might improve healthcare for patients, doctors, and scientists. The benefits of customized and research treatment will be maximized by establishing granular data access rights, monitoring individualized data in real-time, and building a central repository for all health data. To better manage healthcare data, Anuraag et al. looked at blockchain technology. They considered a wide range of articles for their research; much of it speculated about the advantages and disadvantages of using blockchain technology in the healthcare industry without providing proof or a system evaluation. The group has finished debating whether or not blockchain technology is more suitable than existing solutions for managing patients' health information in the cloud without compromising patient confidentiality.

When it comes to healthcare management, Khezr et al. found several problems that may be solved with the use of blockchain technology. They highlighted the current research on the application of distributed ledger technology in healthcare and numerous prospective medical applications where blockchain technology may play a critical role in improving efficiency. They also proposed a way for delivering IoMT over existing network infrastructure.

Researchers in the healthcare field are reliant on large sets of data to construct tailored therapies that are based on lifetime, the environment, and genetics, promptly monitoring the development of novel pharmaceuticals, accelerating biomedical discovery, and expanding understanding of the condition. The shared data system in the blockchain would provide a diversified collection of data if it included patients from a wide range of ethnic, socioeconomic, and geographical backgrounds. As blockchain records medical information over a person’s whole life, it is well suited for longitudinal studies. Through the use of a healthcare blockchain, those who are underserved by the medical community or who are not generally engaged in research may be included in studies. Because of blockchain’s shared data environment, it is much easier to include formerly difficult-to-reach communities and boost public confidence in the reliability of results. Smart healthcare systems, as can be guessed, need copious amounts of data sharing between medical professionals and their respective tools.

A “blockchain” was developed to link all the databases on the network to address this issue. As time goes on, blocks of data are added to a distributed ledger and secured using cryptographic hashing in what is known as a blockchain. Each record includes a cryptographic hash of the previous record to prevent constant unnecessary modifications. A blockchain is recognized by its immutable “ledger,” which implies that once a record is recorded, it cannot be changed in any manner and is available to individuals and under their control. This is the basic aspect of the smart contract system with which the blockchain conforms to the maintenance of one’s identity. Therefore, only licensed medical professionals are allowed to access patient electronic medical records (EMRs). The “MedBlock” is a blockchain-based information management system that provides immediate EMR access and retrieval thanks to its secure access control and encryption. Vangipuram et al. developed a blockchain implementation and edge architecture called the “Healthcare Data Gateway” (HDG) to ensure the privacy of medical records for COVID-19 patients being transferred to hospitals. To combat the spread of the COVID-19 virus, Alsamhi et al. developed a blockchain setup for a distributed network of robots.

### III. METHODS

This systematic review aims to establish the present standing of blockchain in the IoMT. This investigation was conducted with due diligence by thoroughly reviewing the relevant literature published in the present situation. Structured research questions, databases, and methods for locating and analyzing evidence are all part of the review process. Characteristics of the recommended items in reporting for conducting systematic reviews have been selected to provide a clear, quantitative, and thorough assessment of existing applications in healthcare based on blockchain technology and IoMT. The following points are the main phases in the overall plan.

Results from answering the research questions presented in the previous systematic review are listed in this section. This study seems to make a substantial contribution to the use of blockchain in the medical field. This part introduces blockchain-based IoMT and covers its fundamentals, different varieties, development teams, platforms, and consensus processes. The importance of using blockchain and IoMT in healthcare is discussed further on. Because of its sensitivity, volume, and importance, medical data requires rigorous guarding.

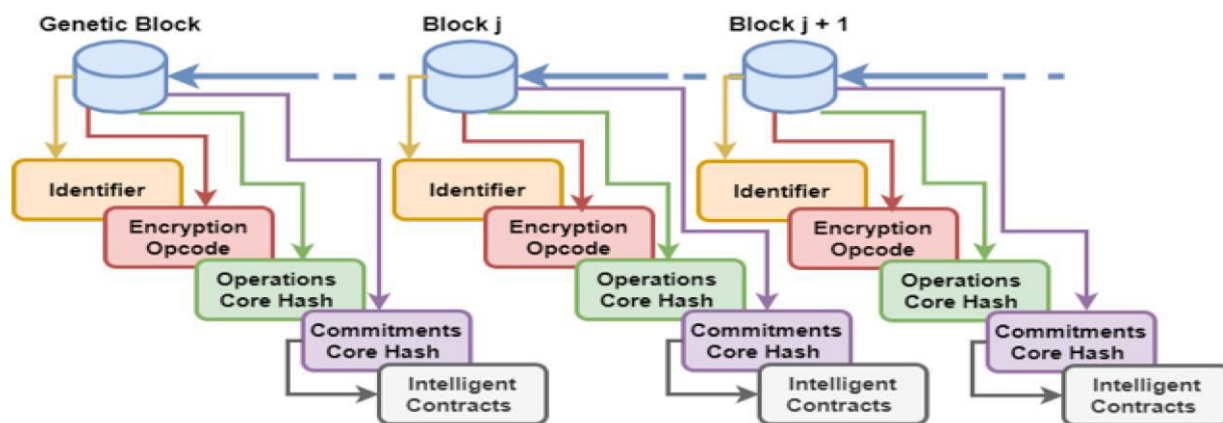


Fig 2: blockchain-based framework for security and privacy



Furthermore, blockchain technology is paving the way for innovative approaches to healthcare data management, access control, sharing, retrieval, storage, and more. Now that blockchain technology is introduced, researchers are more focused on employing blockchain strategies to ensure the security of applications in healthcare. IoMT problems emerged as soon as IoT systems started incorporating medical devices. The lack of consistency is a major barrier. The extensive application of blockchain technology in healthcare is expected to bring along a rise to new “smart” healthcare provider applications that sidestep the latest medical research and create individualized pathways to address the situations. The same level of access to information will be provided for both the patient and the healthcare professionals allowing them to engage in a productive dialogue based on hard facts about the best course of therapy for the patient’s illness.

#### IV. RESULT ANALYSIS

Data can be stored in the blockchain’s blocks (which is challenging because of the scalability issues), data provenance can be exploited by storing the locations of data in the blockchains rather than the data itself, and distributed storage can be used in tandem with the blockchain to serve as off-chain storage. The data that could be easily accessed and utilized would never have to be sent over the network in any of the systems.

It is obvious that user-centric solutions are becoming more popular, even if it is not the primary focus of the study. Despite efforts to give consumers more control over their data, developing a truly decentralized system that is user-centric for health data remains a challenge. Authorized systems that are controlled by healthcare institutions are not always clear, since they may provide consumers more control over their data but ultimately need them to comply with consortium norms around data management. Decentralized storages run the danger of being squandered because of this security issue in permissioned systems, which reduces their value. Even in the case that user data is stored in a decentralized manner on the blockchain, this does not ensure a user-centric system if the blockchain might be tampered with by participants. Several actual uses demonstrate.

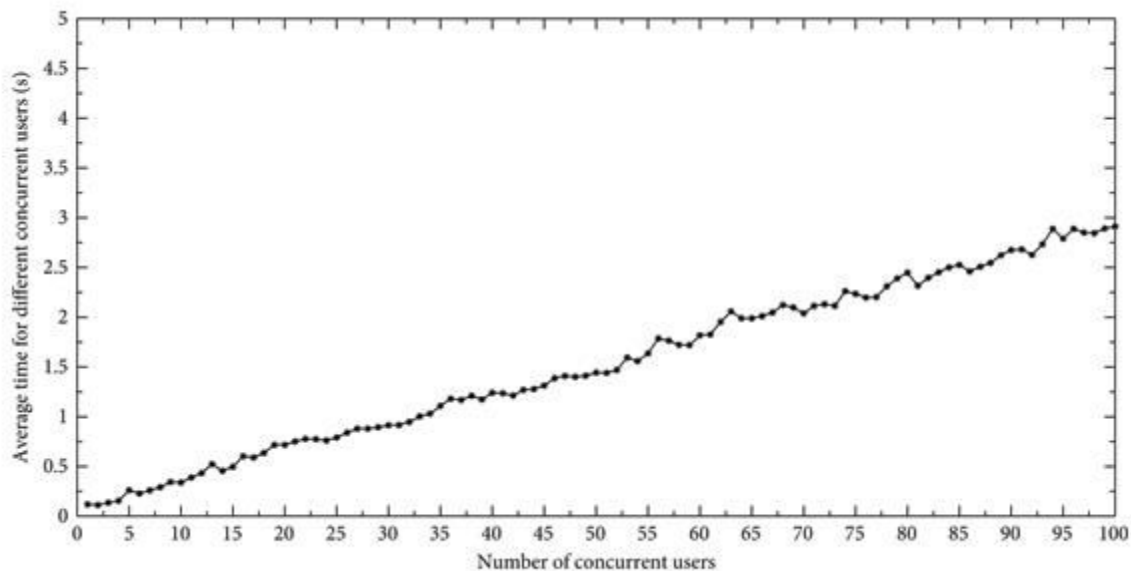


Fig 3: Result analysis

If these networks can incentivize users to share personal healthcare data with the community in exchange for benefits, it would be even more astounding if a solution could be found, maybe via hybrid implementations between permissioned and permissionless implementations. No one ever receives credit for the value added by their usage of an IoMT system or an IoT device. In most cases, when people pay for expert assistance, their investment exceeds the results they see. As a matter of fact, in theory, they help advance scientific understanding. Certainly, data sharing and crowdsourcing might be made possible by the Internet of blockchains in a blockchain-enabled society.

To do this, however; it must be shifted from a viewpoint that is rather system-centric, in which a user is just the end consumer of the application, to a user-centric stance, in which a user is an integral part of the design process. A method where each user stores their data locally, as on a smartphone or other portable device, may be quite appealing. If these gadgets serve as secure, distributed storage, then any unknown entity might have easy access to the information kept there, subject to the restrictions set by the users who are the rightful proprietors of the material being shared.

## V. CONCLUSIONS

A growing number of people are paying attention to the blockchain-based Internet of Medical Things (IoMT) since not only it is likely to reduce healthcare costs but also it can enhance the quality of treatment by relying on continuous and real-time continuous monitoring. IoMT sensor nodes, Internet of Things (IoT) wearable medical devices, patients, healthcare facilities, and insurance companies are just some of the numerous entities that are increasingly being included in IoMT systems. As scalability is one of the key features of blockchain technology, it is challenging to develop a blockchain framework for such systems. This review of blockchain-based IoMT solutions created between 2017 and 2022 was inspired by this insight. The aim is to explore the current state of blockchain technology, the applications it has found, and how its unique features could alter current practices. This study integrates the theoretical foundations of a significant body of work that has been published in prestigious academic publications over the last ten years to standardize assessment techniques and completely capture the blockchain realm, which is quickly evolving. There were 73 papers in the relevant field that are evaluated. Based on a structured, systematic examination and thematic content analysis of the available literature, this research classifies blockchain-enabled applications across a range of sectors, including supply chain, business, healthcare, IoT, privacy, and data management. With a particular emphasis on the limitations presented by blockchain technology and the ripple effects such limitations have in other sectors, the gaps in the literature on the subject have also been emphasized.

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