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BLOCKCHAIN TECHNOLOGY AND THE MEDICAL SCIENCES

Medicine

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ABSTRACT

Medical science is the most important field of study directly related to the well-being of society. Medical science has its own set of problems which reduce the efficiency of the Healthcare system. Many of the problems relate to record keeping, medico-legal issues and ethics. A new system or the technology like Blockchain technology can enhance the efficiency of the field of Medical science as a whole. This paper looks into the various aspects of using Blockchain technology in Medical science.

First, we introduce the concept of Blockchains. Then we discuss the present status of Medical science research and Healthcare. How the Blockchain technology can be applied to medical field is analyzed along with various pros and cons of Blockchain technology. The probable impact of Blockchain on Healthcare is evaluated. The paper concludes by summarizing the consequences and suitability of using Blockchain technology in Medical sciences and Healthcare services.

KEYWORDS

Blockchain, Medicine and Blockchain, Patient Doctor Confidentiality, Medical Record, Technology and Medicine

Introduction

A Blockchain is a widely disseminated archive of data that maintains a continually expanding register of records, completely and reliably protected from any alteration or modification. Each block has a timestamp and a link to the preceding block. Unmodifiable and dependable data can be accessed by all and easily.

A blockchain, is an ever-growing bundle of records, called blocks. They are stacked and secured using cryptography. Each block typically contains a cryptographic hash pointer which links to a [chronologically] previous block, with a timestamp [timestamping keeps track of time of the formation and alteration of a record], and transaction data. These blockchains are structured to be impervious to data manipulation. Once formed they are permanent records, verifiable by anybody but non-modifiable. Blockchains are decentralized and distributed ledgers, and they are maintained by a peer-to-peer network, strictly observing a predetermined protocol for validating new blocks. Once formed, the data in any given block cannot be altered retrospectively without the alteration of all previous blocks, which is not possible without the consent of the network.

The present centralized data is more controllable. But it is amenable to information and data manipulation. By decentralizing it, blockchain makes data transparent to everyone involved.

Hence the blockchains are ideal for the recording of various events, more so medical documents.

A blockchain is formed by blocks linked to each other chronologically as they are formed.

The coding of data in the blocks forming the blockchain are done through a set of mathematical steps [algorithm] known as Hash.

A hash function mathematically shortens the long chain of texts and numbers [of data] into short strings of letters and numerals.

A hash is a function that is used to map data of any size to data of fixed size. One hash is created for each of the transactions in a block. The values resulting from a hash function are called 'hash values' or just 'hashes'.

This hash system has several advantages.
It can shorten the message, and at the same time it is verifiable.

The final block id, unique for each block is created by combining several hashes [each of which represent a single data in the block] under a set of criteria, so that the accuracy of the block's contents can be verified just by examining the final hash. Even a small change in contents of block can alter the whole hash output [and hence the hash identity] unique to that block. Then it will not meet the expected criteria, and hence cannot be fitted into that particular chain.

The creation of these hashes is done on a principle known as Merkle tree. It is a system, wherein a large number of data are shrunk and integrated into a unique 32-character alpha-numeric (containing letters and numbers) string.

Each block contains the summary of all the transactions in a block in a form known as the Merkle tree. To complement [tally with] the preceding block in time, the final block hash [block id] must meet certain criteria.

Computers run the entire hash contents of a block.

Each Block holds number of valid records of events as they occur in real time. These records are hashed and encoded. Each block contains the hash of the previous block in the blockchain, which links both of them. The linked blocks form a chain. This time stamped link confirms the validity of the previous block, all the way back to the original first block.

Data stored on the blockchain is incorruptible.
This is where blockchain has its advantage.

Centralized data need to be authenticated by an authority. But Blockchains are automatically validated ledgers. They assuage the need for a guaranteer. Blockchains once formed, are not amenable to frauds. They automate processes that are manual and time-consuming.

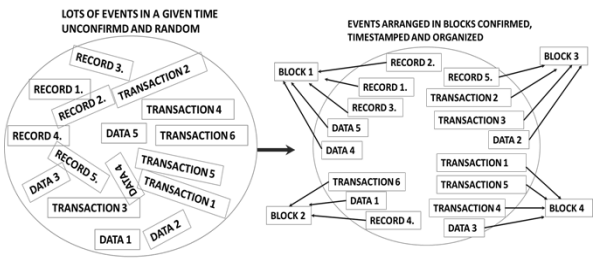


FIG 1- BLOCK FORMATION OUT OF RANDOM DATA GENERATED IN REAL TIME

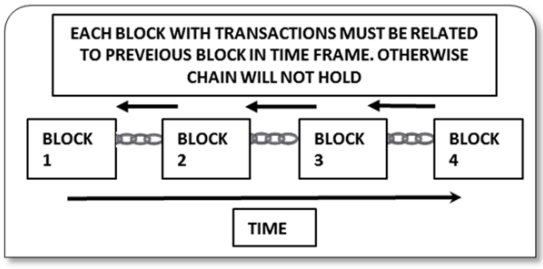
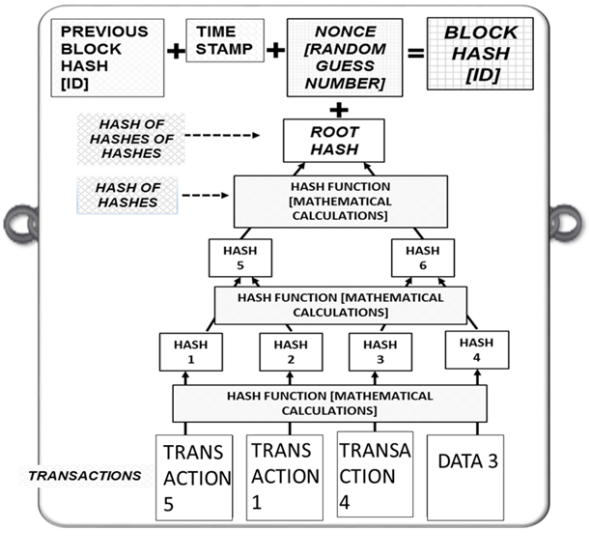


FIG 2- BLOCKS OF EVENTS APPROVED & SEALED.

FIG -3
TYPICAL BLOCK IN A BLOCKCHAIN



Medical science is the branch of science concerned with the study of the diagnosis, treatment, and prevention of disease. It contains a vast array of various subjects ranging from anatomy, immunology, forensic science, to Neurology, cardiology, etc. Like any other active field of research, it is data intensive. Data in the medical field is collected for individual diagnostics, post-facto analysis, collective health trends, testing treatment efficacy, research etc. hence, one can infer that medical science is an extremely data intensive field. For data to be useful in the medical field, it needs to be wholesome, in that it should not be falsified. Data integrity is of paramount importance. It means that the source from which data is generated should be reliable and has also to be recorded in a fashion that can be certified as reliable. Added to this milieu is the fact that patient privacy and confidentiality has to be maintained at any cost. This means that patient data may be accessible by the patient himself/herself and only the doctor treating the patient but no one else. Thus, data used for medical science needs to be wholesome, tamper-proof and confidential at the same time.

It therefore seems natural that medical science can make use of blockchain technology for recording, storing and selective access of data. We shall now analyze the various aspects of possible uses of blockchain technology with the medical sciences.

Advantages- Let us first discuss the various advantages of Blockchain technology.

1) Tamper-proof- Since a Blockchain is formed by a series of blocks containing time stamped data which is verified and only then added to the chain, Blockchains have high security. Data that is already part of Blockchain is difficult to tamper with. This feature is very important where data privacy and integrity is concerned, like in the medical field.
2) Decentralized- Blockchain by nature is a decentralized system. Hence, single point failures, common to a server or cloud-based systems (which are centralized in nature) are a rare occurrence. Hence, Blockchain systems are ideal to store sensitive research data and patient information (including identity information)
3) Data confidentiality- Blockchain provides an immutable chain of authority that is difficult to hack thus providing a high degree of data confidentiality. This is very important for medico-legal purposes
4) Standardization is possible- There are several formats in which medical data is recorded. This makes conciliation and data analysis problematic where more than two formats of medical records is concerned By adopting Blockchain technology, it will be possible to prescribe a global medical record standard which can be used by medical professionals to readily upload medical data on the Blockchain.
5) Any activity can be monetized- Just as brands can be monetized using Blokchains, hospitals and healthcare entities can monetize their brand value without giving away equity.
6) High security- In an ideal decentralized arrangement, the addition of more nodes reduces the risk of the system failing. If one node fails; the whole network is not weakened. Blockchain is a system providing for high security due to its decentralized nature. Stealing of data thus becomes difficult for hackers.
7) Smart contracts- A smart contract is a computer protocol designed to facilitate, validate, or administer the negotiation or performance of a contract. Smart contracts proposed by Nick Szabo in 1994, allow to accomplish reliable transactions without third parties. These transactions are trackable and irrevocable. Blockchain can be used to generate smart contracts that can smoothen supply chain management of Pharmaceutical drugs, Health insurance, Medical certification, etc.

Disadvantages

1) Present lack of understanding of Blockchain technology in the medical field- As of now, health professionals have very little understanding of Blockchain technology. Over time, with increasing awareness, this disadvantage can be remedied
2) Present lack of regulation of Blockchain technology by Governments. -Blockchain technology is, as yet an unregulated technology. Governments across the world are studying it and in a given period may come up with certain policies to regulate blockchain technology and safeguard public interest. A lack of regulation may be hindering development of use cases as institutional investors may not be attracted to a technology that is unregulated.
3) Absence of a Blockchain model and protocol on which medical field use cases can be developed- Due to the novelty of Blockchain technology, use cases are yet to be developed for application in Medical science.
4) Source certification and accreditation Infrastructure is, as of now, non-existent: data that is to be recorded on the Blockchain needs to be verified or certified by some trusted authority or source. Presently, such a system of accreditation and standardization is absent as far as Medical science is concerned.

The impact of Blockchain Technology on medical sciences and healthcare may be as follows:

A) Hospitals will see a large amount of Paper-work like drafting, recording transfer etc. to be automated as Blockchain technology makes data secure and immutable.
B) Hospital procedures will be greatly simplified due to quick verification of legality (and credibility) of certificates, reports, documents etc. through the Blockchain.
C) Criminal records, put on the Blockchain will make identification and case-solving easier and less cumbersome.
D) Large-scale processes like clinical-trials, mass-vaccination programs, disaster management etc can be monitored and managed better due to improved data management if Blockchain technology is used.

Conclusion

We have seen how Blockchain technology provides a decentralized network for medical data to be recorded and transferred securely. It also provides for safe data keeping and reliable management. It has the potential to streamline medical supply chain, research and patient care. It also has implications in medico-legal issues that need the data to be immutable and tamper-proof. Moreover, it also enables us to keep the data confidential by providing selective access to health care professionals. Most of the disadvantages derive out of the nascent nature of the technology itself. With prudent regulations from government and development of use cases, Blockchain technology can become the mainstay for data management and advancement of the medical field.

[Illustrations by Dr. Vasantmadhav Hegadekatti, M.D., from the book

PERFECT MONEY published by Hamsa Publishers Bangalore, India.]

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