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HOSTING A BLOCK CHAIN CODE ON TO A CLOUD NETWORK IN ORDER TO CREATE A PROTOTYPE APP IN THE HEALTHCARE SECTOR-A SURVEY

[1]Neha Muley,[2] Renuka Panchawate,[3]Trupti Bawane,[4]Ishwar Surjushe,[5]Rohini Lonare

[6]Prof. Y. A. Thakare*

[1-5] U.G Student, Department of Computer Science & Engineering, Sipna C.O.E.T, Amravati,

[6]Assistant Professor, Department of Computer Science & Engineering, Sipna C.O.E.T, Amravati, India

ABSTRACT:

Blockchain technology was developed to make it easier for people to exchange money, do away with the requirement for a reliable third party to notarize and verify transactions, and safeguard data confidentiality and privacy. In order to facilitate data sharing and enhance interoperability among patients, hospitals, clinics, and other medical stakeholders, this project uses block-chain technology to manage and distribute electronic health and medical records. The entities taking part in the built-in chain network determine which blockchain's architecture is employed. Although the usage of blockchains may eliminate duplication and give carers consistent patient information, it still has several drawbacks that could undermine the entire stakeholder network or violate patient privacy.

Keywords: 1.Blockchain Technology 2.Cloud Network 3.Security 4.Healthcare Sector 5.Prototype App

1.INTRODUCTION: Better health is important to human happiness and the welfare of society. It plays a vital role in the economic progress of the nation. Ill health, casualty, emergencies occur every day and the diseases are expected to be diagnosed and treated. A health record is a collection of clinical data related to the patient's mental and physical health, gathered from different sources. Health record consists of a patient's medical history, examination, diagnosis, treatment, results of lab investigation, scanning reports, alerts like allergic to etc. These health records can be managed both manuallyand digitally.

The traditional method which is followed in most of the hospitals for maintaining records is the manual method which includes papers and books. This method has serious limitations such as a need for large storage areas and

retrieval of records is difficult. In the present era computerization of clinical records has become popular asthe storage and retrieval of the records is easy. However, the chances of manipulation without identification has become a serious concern[1].

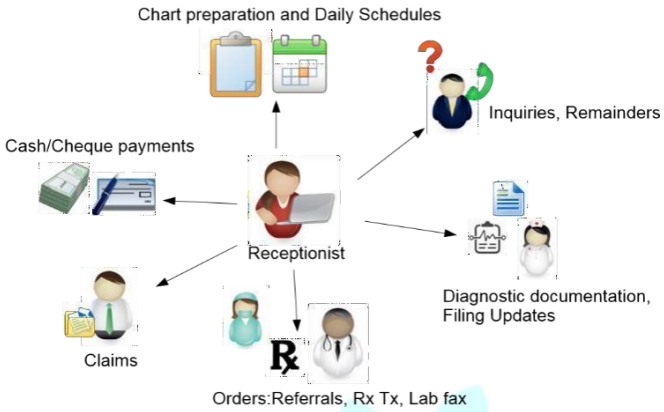

Fig1.1 Hospital Activity diagram

Another major perturb is the maintenance of patient records confidentially as the patient can hold the doctor and the hospital irresponsible for breaking the confidentiality of his medical records. Also, paper-based records are often incomplete, giving rise to unwanted repeat testing and medication. There is wastage of time since this system needs more manual power for transferring records by mail or faxes as these are dispersed and are not centralized. Even accessing of medical records by doctors is limited. Health records can be easily and quickly shared between medical institutions by integrating digital technologies in the healthcare system. In this respect there are intense queries about the storage of patient's data, providing authorization to access the data, security & immutability of the data. These problems can be solved by developing a decentralized digital health infrastructure that is by integrating Blockchain technology into the healthcare system [5].

Blockchain technology has the capability to rebuild the modern economy by maintaining and updating record. Within the next decade, health care services and applications are expected to generate trillions of dollars in revenue due to their integration as part of the Internet of Things (IoT) paradigm. Most remarkably, smart healthcare has shown significant reduction to mortality rates and cost of healthcare, while improving quality, for instance, by reducing emergency room (ER) visits and hospital stays . Being voluminous, health care records are best stored in the cloud to enable easy access and sharing of information among the different stakeholders[3]. In addition, the security and privacy measures offered by the cloud increase the resiliency of data. However, the use of cloud storage does not allow interoperability between the different care providers. In addition, the integrity and authenticity of the data cannot be guaranteed. One possible technology to enhance integrity, authenticity, and consistency of stored and exchanged medical records is Blockchains. Blockchains can guarantee security of sensitive data by tracking access to confidential medical records and ensuring authorized access. Blockchains can serve as a distributed database that hardens medical reports against tampering. As a distributed trusted mechanism, Blockchains addresses security issues associated with a deployed distributed database of patient records which could be managed by different advisories such as caregivers, hospitals, pharmacies, insurance companies, regulators and the patients themselves. Blockchains as a technology relies on public key cryptography and hashing mechanisms as a mean to keep track of historical

transactions pertained to distributed patients' records while preserving confidentiality, integrity and availability[4]. This will ensure that records are not lost or being wrongly modified, falsified or accessed by unauthorized users. In Blockchains, patients' records can only be appended to the database, but not removed. New information can be securely linked to a previous record using cryptographic hashing[9] .

Records are added to the blockchain based on a consensus among the majority of miners in the blockchain. Miners are a set of special nodes working together to validate new transactions added to a blockchain. To be able to add a record to a blockchain, miners have to compete to solve a difficult mathematical problem known as Proof of Work (POW) which takes 10 minutes on average[6]. Blockchain is a decentralised and public digital ledger that records transactions on many computers so that no record involved can be altered retroactively without altering any blocks afterwards. Blockchain is verified and linked to the preceding 'block,' forming a long chain. After all, Blockchain is the name of the record. As any transaction is registered and checked publicly, Blockchain provides a good deal of accountability. When entered, no one can modify all the information written in the Blockchain. It serves to demonstrate that the data is actual and unchanged. In Blockchain, data are maintained on networks instead of a central database, improving stability and showing its proneness to be hacked. Blockchain offers a fantastic forum to develop and compete with traditional companies for modern and creative business models [2].The EHR systems have been implemented in a number of hospitals around the world due the benefits it provides, mainly the improvement in security and its cost effectiveness. They are considered a vital part of healthcare sector as it provides much functionality to the healthcare. These functionalities are electronic storage of medical records, patients" appointment management, billing and accounts, and lab tests. They are available in many of the EHR system being used in the healthcare sector. The basic focus is to provide secure, temper-proof, and shareable medical records across different platforms. Despite the fact that notion behind usage of EHR systems in the hospitals or healthcare was to improve the quality of healthcare, these systems faced certain problems and didn't meet the expectations associated with them. A study was conduct in Finland to find the experiences of nursing staff with the EHR, it was concluded that EHR systems faced the problems related to them being unreliable and having a poor state of user-friendliness.

The EHR system also faces some other problems which are as follows:

1.Interoperability: It is the way for different information systems to exchange information between them. The information should be exchangeable and must be usable for further purposes. An important aspect of EHR systems is its Health Information Exchange (HIE) or in general data sharing aspect. With a number of EHR systems being deployed in various hospitals they have a varying level of terminologies, technical and functional capabilities which makes it to have no universally defined standard. Moreover, at technical level the medical records being exchanged should be interpretable, and that interpreted piece of information could be further use.

2.Information Asymmetry: Today the greatest problem in healthcare sector defined by the critics is information asymmetry which refers to one party having better access to information than the other party. In case of EHR systems, or in general healthcare sector is suffering from this problem as doctors or hospitals have access to the patients records, thus making it central. If a patient wants to access his medical record she would have to follow

a long and tedious process to access them. The information is centralized to only a single healthcare organization and its control is only provided to the hospitals or organizations.

3.Data Breaches: Data breaches in healthcare sector also calls for the need of a better platform. A study was done for analyzing the data breaches in EHR systems and it depicted that 173 million data entries have been compromised in these systems since October 2009. Another study conducted by Argaw et al[16], explains that hospitals have become a target of cyber-attacks and an increasing trend has been witnessed by the researchers while conducting this study that a lot of research work has been done in this domain[8].

2.OBJECTIVE:

- To produce confidentiality for patient medical recordsvictimization using "Blockchain Technology".
- To provide Patient information secrecy or confidentiality which is necessary pillars of drugs.
- To Protect the personal details of a patient to bond trust between the doctor and also the patient.

3.Literature Review & Related work:

Satoshi Nakamoto et al. [1], provided the basic idea, to have a cryptographically secured and a decentralized currency that would be helpful for financial transactions. Eventually, this idea of blockchain was being used in various other fields of life; healthcare sector also being one of them intends to use it. A number of researchers have carried out the research on this area, these research works focus on the fact that whether the idea of using blockchain for healthcare sector is feasible or not. They also identify the advantages, threats, problems or challenges associated by the usage of this technology. Some researchers also discussed the challenges that would be faced while actually implementing this on a larger scale.

Gordon and Catalini et al [2], conducted a study that focused on the methods by which blockchain technology would facilitate the healthcare sector. They identified, that healthcare sector is controlled by hospitals, pharmaceutical companies and other involved third parties. They specified data sharing as the key reason why blockchains should be used in healthcare. This study also identified four factors or approaches due to which healthcare sector needs to transform for usage of blockchain technology. These include way for dealing of digital access rights, data availability, and faster access to clinical records and patient identity. It also discusses the on-chain and off- chain storage of data. The study also included the challenges or barriers faced by usage of blockchain technology these were huge volume of clinical records, security and privacy, patient engagement.

Eberhardt et al. [3], conducted a study to understand possible approaches to solve the scalability problem of blockchain and also to identify such projects that intend to solve this problem. They define blockchain as composition of various computational and economical concepts based on peer-to-peer system. The aim of this study was to find which data should be stored on-chain and what It could be stored off-chain . This study presented five patterns for off chain storage of data and also includes the basic ideas and implementation framework of these patterns. The authors explain on-chain data is any data that is stored on the blockchain by performing transactions on it. While off chain data storage is to place data elsewhere on any other storage medium but not on-chain and it also would not include any transactions.

Vujičić et al [4], presented an overview of blockchain technology, bitcoin and Ethereum. The authors define that information technology landscape is constantly changing and blockchain technology is benefiting the information systems. They explained bitcoin as a peer-to-peer distributed network used for performing bitcoin transactions. They also defined that proof-of-work consensus algorithm along with the mining of blockchain concept. The authors emphasize on the fact that scalability is a severe problem faced by blockchain and that certain solutions are proposed for solution of scalability problem these include Seg Wit and Lightning, Bitcoin Cash and Bitcoin Gold. The paper also explained Ethereum and its dependencies and it also differentiates Ethereum blockchain from bitcoins‟ blockchain.

Wang et al[5], conducted a study that focused on smart contracts and its application in blockchain technology. They first introduce the smart contracts, their working framework, operating systems and other important concepts attached with them. The authors also discuss that how could smart contracts be used for the new concept of parallel blockchains. They identify that reason of using smart contracts in blockchain is due to the decentralization that is offered through the programming language code written in them. After introducing the basics of smart contract the author explained the various layers of blockchain that combine together to keep system functioning. These layers are data, network, consensus, incentive, contract, and application layer. The paper not only discusses the architecture and framework followed by smart contracts but it also gives an insight on its applications and challenges. The paper also discusses an important future trend of parallel blockchain that intends to create such blockchain that can optimize two different but important modules.

Kuo et al [6], conducted a review that discussed several applications of blockchain in biomedical and healthcare sector. The authors identified that using blockchains for this domain offers many advantages and some of these are decentralization, persistence of clinical or medical records, data pedigree, and continuous accessibility to data and lastly secure information being accessible to biomedical or healthcare stakeholders. The limitations of blockchain technology were identified to be, confidentiality, speed, scalability and threat of malicious attack, i.e., 51% attack.

Zhang et al[7], proposed a scalable solution to the blockchain for clinical records. The basic aim of this study was to design such an architecture that complies with the Office of National Coordinator for Health Information Technology (ONC) requirements. This study identified the barriers that this technology faces mainly include concerns related to privacy, security of blockchain, and scalability problems related to huge volume of datasets being transmitted on this platform, and lastly there is no universal standard enforced for data being exchanged on blockchain. This study also include a demonstration of a decentralized application (DAPP) based on the design formulated on the ONC requirements as mentioned before. They also included the lessons learnt and how can FHIR chain be improved.

Kim et al [8] proposed a system for management of medical questionnaires and the aim of this system is data

sharing through blockchain technology. The authors explain that selection of data storage and sharing of medical questionnaire is to use this data for further medical and clinical research purposes. They emphasized that it would be helpful for developing diagnosis system, resolving terminologies being used in EHR systems and security issues associated with these systems was also a reason due to which authors selected blockchain technology for their proposed framework. This study contains two main functions, i.e., to create, store the data gathered by questionnaires and to share that data. Another benefit proposed by the system is the validation of the questionnaire being submitted in the system. The questionnaires that are added on this system are first validated to be correct specified format and then are parsed to differentiate the personal data and specific data .This would ensure that data could be shared for future research purposes. The authors also address the scenario when a third-party requests access this questionnaire data, this would need the patients‟ permission that is asked by the doctor to let third party view that data.

Sahoo and Baruah et al[9], proposed a scalable framework of blockchain using Hadoop database. In order to solve the scalability problem of blockchain, they proposed to use the scalability provided by the underlying Hadoop database along with the decentralization provided by the blockchain technology. They used the method to store blocks on the Hadoop database, the blockchain on top this framework includes all of the needed dependencies of blockchain but the blocks are stored on Hadoop database to improve scalability of the blockchain technology. To tackle the scalability problem of blockchain platform this study offers to use Hadoop database system, along with SHA3-256 for hashing used for transactions and blocks. The programming language used for this architecture was Java. This study, was helpful in understanding that blockchain can be used with other platforms that are scalable to improve or solve the scalability of this platform.

Zainab Alhadhrami et al[10], discussed the various kind of blockchains architectures available in the present scenario and discussed the basis of all the types of blockchains and how it can be used in the healthcare sector for maintaining, validating and storing the data. Also, the system that mostly came out of the box for storing of the healthcare data was marked to be the consortium blockchain. Consortium blockchains are basically those which are permissible blockchains where the node owner, as well as the miners, get the access control. Moreover, the consortium blockchain works on the theory of consensus from a majority number of stakeholders or the nodes associated with the blockchain network.

4.FINDINGS:

Our review of the literature was able to compile a list of the various techniques used in those studies. Also, from the viewpoint of the relevant authors, discussed the best practises for specific publications. How can patient medical records be protected and investigated? Keeping patient medical records confidential is crucial, but doctors and other healthcare professionals will access the data in a very secure way. One of the biggest problems in our modern world is the upkeep of patient medical records. There were numerous solutions to this issue. Digital Health Records Block-Chain technology can also be used to maintain confidentiality. Blockchain technology, commonly referred to as distributed ledger technology, is a better approach to offer secure medical records.

5.PROPOSED SYSTEM:

5.1.SYSTEM ARCHITECTURE

To understand the blockchain architecture let us use the following figure 5.1 that explains the whole process of a transaction being send from a user on the blockchain network.

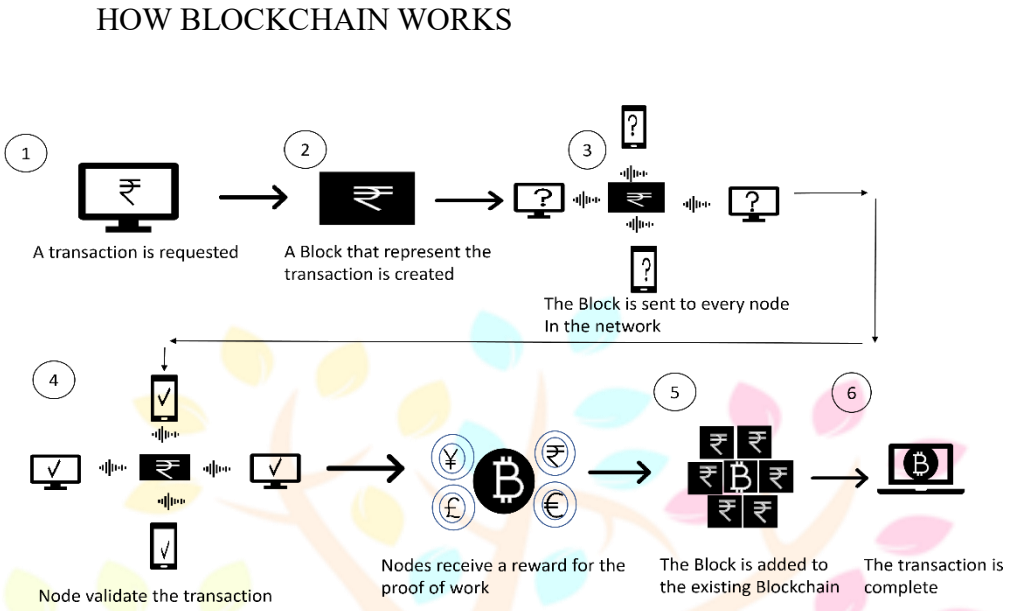

Fig5.1. An Overview of Proposed Blockchain Architecture

1.A new transaction being sent by a user on the blockchain network suggests that a new block is created. A block in the blockchain is used for keeping transactions in them and these blocks are distributed to all of the connected nodes in the network. That transaction placed inside a block is broadcasted to all of the nodes in the network. All the nodes in the network have a copy of the complete blockchain that helps them in verification process. When a block containing the user transaction is broadcasted to all of the connected nodes, they verify that the block is not tampered byany means. If this verification results in success then the nodes add that block in their own copy of blockchain.

2.This whole process of the block being added on the blockchain is done by the nodes reaching upon a consensus where they decide which blocks are valid to be added on the blockchain and which are not. This validation is performed by the connected nodes using some known algorithms to verify the transaction and to ensure that sender is an authenticated part of the network. When a node succeeds in performing the validation that node is rewarded with crypto- currency. This process of validatingthe transaction is known as mining and the node performing this validation is known as miner. After validation is done, that block is added to the blockchain.

3.After the whole process of validation is performed the transaction is completed. As we can see above, the Blockchain structure is highly complex but ensures that there is security built into the core system. All nodes in the network make the structure increasingly safe to interact in. This has enabled greater control using

Blockchain, as more data can be transmitted using the technology. Additionally, from a purely functional standpoint, there are more significant advantages to using Blockchain over traditional formats. There are poorer control and fewer compliance measures present in usual standards. Additionally, the investment required to make a conventional data storage network security is immense. Blockchain comes in and ensures that data are saving and cost saving benefits to storing data over the distributed ledger.

5.2. BLOCKCHAIN USE CASES IN HEALTHCARE:

Blockchain has been leveraged extensively to enhance data storage and patient private documents. The technology has been used to ensure that the Healthcare value chain is self-sustained as well. This is important to know as many in the industry are exploring the full potential of the technology as well. They're developing nuanced solutions that rely on Blockchain technologies in the ecosystem.

Ideally, the best way to approach Blockchain is to understand how it impacts the Healthcare space holistically. From billing to the patient introduction, there are multiple points in the patient journey that Blockchain can aid in. It can provide increased security in the value-system so that no information is being misused and all compliances are being followed as per norm. There is also greatercontrol over the information flowing from one end to another.

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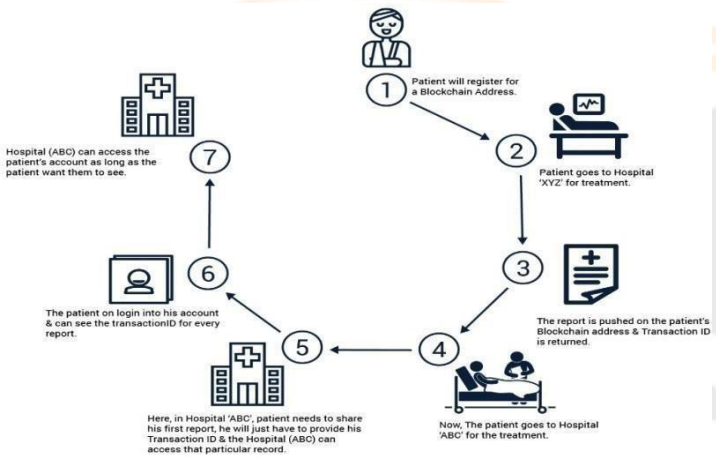

Fig.5.2. Blockchain to increase Healthcare security[17]

From Healthcare fraud to incoming threat detection, there is the various application of the technology that is yet to be explored fully. Leaders in the healthcare space must look at the technology from a holistic stand-point and explore all options available. As a patient goes from one center to another, transferring that data correctly becomes critical. That's where Blockchain can share secure information across a laid-out pathway.

Regarding storing data away from traditional servers, Blockchain can facilitate that as well. The fundamental nature of Blockchain ensures that there are no single nodes that can capture the entire information at one point. The distributed ledger provides that there is data integrity as well. This means that all locations within the network contribute equally to the entire network's success.

5.3. Blockchain-based Healthcare Management Applications:

With the progress in electronic health-related data, cloud healthcare data storage and patient data privacy protection regulations, new opportunities are opening for health data management, as well as for patients convenience to access and share their health are immensely valuable to any data-driven organization, especially in healthcare where blockchain technology has the potential to resolve these critical issues in a robust and effective way. Figure 3 shows seven steps of healthcare data management workflow in blockchain, which are discussed below. Blockchain based applications in this category include data sharing, data management, data storage (e.g., cloud- based applications) and EHR, which are discussed in details below

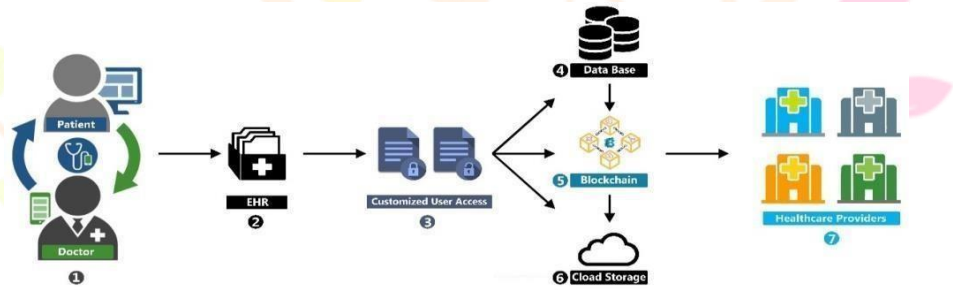

Fig.5.3. Healthcare data management in blockchain[17]

- Step-1: Primary data is generated by the interaction between a patient and their doctors and specialists. This data consists of medical history, current problem and other physiological information.
- Step-2: An EHR is created for each patient using the primary data collected in the first step. Other medical information such as those generated from nursing care, medical imaging, and drug history are also included in EHR.
- Step-3: Individual patient who has the ownership of sensitive EHR, and customized access control is given only to the owner of this property. Parties who want to access such valuable information must request permission which is forwarded to the EHR owner, and the owner will decide to whom access will be granted.
- Step-4, 5, and 6: These three steps are part of the core of the whole process including database, the blockchain, and cloud storage. Database and cloud storage store the records in a distributed manner and a blockchain provides extreme privacy to ensure customized authentic user access.
- Step-7: Healthcare providers such as ad hoc clinic, community care center, hospitals are the end user who wants to get access for a safe and sound care delivery which will be authorized by the owner. For

example, no matter where you are treated in the globe, your health record will be available and accessible on your phone and validated through a distributed ledger such as blockchain, to which healthcare providers would continueto add to over time .

6.GLOBAL SCIENTIFIC DATA SHARING:

Sharing of healthcare and medical data is one main and essential step to improve the quality of healthcare providers and make the healthcare system smarter. Sharing health records could happen between individuals. For instance, a patient who wants toshare his medical historywith a doctor at their first meeting.

In addition, sharing could happen between an individual and a stakeholder, such as a patient sharing his medical history with an insurance company or a research center. Even the data could be shared beyond borders . However, the operational mechanism of today's health-related systems has some limitations. One limitation is that patients hardly have access to their health records. Therefore, they have no idea about the sharing of their own health data among unknown parties. To improve the interaction and collaboration with the healthcare industry, blockchain technology could play a crucial role, enabling and securing a convenient sharing mechanism of electronic health data. This is considered one of the most crucial contributions of blockchain based healthcare. Below, we describe some of the contributions made in this regard.

Castaldo and Cinque[11] suggested a logging system to facilitate and improve the exchange of electronic health data across multiple countries in Europe in the most secure manner using private blockchain. Yue et al. developed a healthcare data sharing application, namely Healthcare Data Gateway (HGD), based on the blockchain architecture. The provided solution helps control and share client's data easily without compromising privacy. It provides an excellent way to increase the intelligence of healthcare systems and at the same time keeps patient data private. Moreover, Vishal Patel presented a framework for cross- domain image sharing by using blockchain technology as a distributed data store to create a ledger of radiological studies and control image sharing by customized user permission. In a similar study, Fan et al[12]. developed a Med Block framework based on blockchain technology to solve data management and data sharing problem in an electronic medical records (EMRs) system and improve medical information sharing.

Patients can access the EMRs of different hospitals through the Med Block framework by avoiding the previous medical data being segmented into various databases. In addition, data sharing and collaboration via blockchain could help hospitals get a prior understanding of patients' medical history before the consultation. Ji et al[15] proposed a multi-level location sharing scheme based on blockchain technology. The goal was to achieve the privacy-preserving location sharing by blockchain for telecare medical information systems. They define the primary requirements for location sharing decentralization, confidentiality, variability, multi-level privacy protection, irretrievability, and unforgeability by using Merkle tree and order- preserving encryption.

7.CONCLUSION: In this paper Blockchain technology was found to be useful in real health care environments, including sharing of healthcare and medical data .In addition, data sharing and collaboration via blockchain could help hospitals get a prior understanding of patient's medical history before the consultation. No matter where you are treated in the globe, your health record will be available and accessible on your phone

and validated through a distributed ledger such as blockchain. Overall, this technology would significantly enhance and eventually revolutionise how patients and physicians treat and use clinical records and improve healthcare services with Security.

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