Blockchain Technology For Electronic Health Records

Define Problem / Problem statement

TEAM ID: NM2023TMID10607

TEAM LEADER: K.ATCHAYA

TEAM MEMBER: A.PRIYA
V.SANGEETHA
E.INDHUMATHI
S.ARUNKUMAR

I. INTRODUCTION

The traditional method for maintaining medical records relies heavily on handwritten documents. This system has many flaws, including disorganised information, a lack of data, documents that may be damaged, duplicate data, inconsistent handwriting, and occasional ineffectiveness. In order to overcome these obstacles, the health care industry has adopted a computer-based record-keeping system. This approach is referred to as "Electronic Health Records" (EHR). The electronic health record is not simply a digital replica of a patient's paper chart. Electronic health records are patient-centered, real-time records that make information instantly and securely accessible to authorised users.

Even though the EHR lets doctors and nurses get information about a patient whenever and wherever they need it to give better care and treatment, there are a lot of things to think about. Due to the rapid evolution of technology, hardware and software must be replaced and updated frequently. In addition, providers must ensure that users of EHRs receive ongoing training and support. End users of an EHR may also experience intense emotional reactions as they adapt to new technology and workflow modifications[1]. When an EHR is implemented, an organization's power structure may also shift. Another potential issue with EHRs is that they may violate a patient's privacy, a growing concern for patients as more health information is shared electronically [2]. To alleviate some of these concerns, policymakers have taken measures to ensure that patient information is secure and kept confidential. EHRs may have unintended consequences, such as an increase in medical errors, negative feelings, changes in power structures, and a greater reliance on technology[3].

The capacity of blockchain to maintain an incorruptible, decentralised, and transparent ledger of all patient data makes it an excellent technology for security applications[4]. While blockchain is open and transparent, it is also private. It conceals individuals' identities with complex and secure codes that protect sensitive medical data. Because the technology is not centralised, patients, physicians, and other health care providers can share the same information quickly and securely. Currently, the most prevalent application of blockchain in healthcare is the protection of vital medical records. The primary objective of this paper is to discuss how blockchain technology can be implemented and used to solve EHR-related issues.

In this paper, the main contributions are summarised as follows: 1) A detailed look at electronic health records and the many benefits they offer in the medical field

2) Discussing the difficulties that EHR has encountered in the current health-care system

II. ELECTRONIC HEALTH RECORDS

The purpose of electronic health records is to facilitate the correct identification of patients during routine clinical procedures. It contains the patient's full name, date of birth, contact information (such as location and phone numbers), and any other personal information deemed essential for healthcare operations. Real-time patient data include physiological parameters such as height, weight, BMI, pulse rate, blood pressure, respiratory rate, and temperature. The EHR system is capable of handling the majority of crucial tasks in the health care industry, such as keeping track of a patient's medical history, diagnoses, medications, treatment plans, immunisation dates, allergies, x-rays, laboratory and test results, and vaccination dates.

Fig: (1) depicts **EHR**

A significant aspect of an EHR is that authorised providers can create and manage health information in a digital format that can be shared with other providers, including more than a few health care organizations [5]. Electronic health records generate a unique clinical ID number that can be used to identify a specific patient within a clinical setting. Multiple-location care providers typically receive a second patient identifier to track a patient across the health network. A third patient identifier may be included if a health system is connected to a state or national health information exchange. The advantage of the system is that it makes things faster, more accurate, safer, and cheaper. EHR's increased and more seamless information flow within a digital health care infrastructure incorporates and utilises digital progress, and it has the potential to alter how care is delivered and compensated. With electronic health records, information is available when and where it is needed. It helps improve patient care and coordination. It aids in analysing the potential outcomes of diagnostics and the quality of care to increase practise efficiency and save money [6].

EHRs' benefits include clinical, organisational, and societal outcomes. Clinical outcomes include enhancements in the quality of care, a reduction in medical errors, and other improvements in clinical measures that characterise the efficacy of care. Other potential benefits include improved financial position and patient and doctor satisfaction with electronic health records. In addition, improved research skills and population health are included among the societal outcomes.

Clinical outcomes: The emphasis of EHR research is on safety and quality of care. Numerous medical situations lack scientific study procedures for providers to adhere to, but the influence of EHR components on reducing medical errors was linked to lower mortality risk and better outcomes.

Organizational outcomes: Both inpatient and outpatient electronic health records are included in organisational outcomes. It increased revenue, avoided expenses, and provided other less tangible benefits such as improved compliance with laws and regulations, enhanced evaluation and research, and increased job and career satisfaction among physicians. Many of the avoided expenses associated with EHRs result from the efficiency improvements generated by having electronic access to patient data. Increased use of tests, decreased staff resources devoted to patient management, decreased costs associated with supplies required to keep paper documents, decreased transcription costs, and costs associated with chart pulls are a few examples. Electronic health records can decrease the necessity for copying test results and sending hardcopies of test results to healthcare sources.

Societal outcomes: Improved research capabilities is an additional, less tangible advantage of EHRs. The electronic storage of patient data increases data accessibility, which may facilitate the identification of evidence-based best practises through quantitative analyses. Moreover, public health researchers actively utilise aggregated electronic clinical data from multiple populations to conduct societally beneficial research. The availability of clinical data is limited, but this pool will grow as more providers adopt EHRs. Public health organisations and researchers will be able to monitor disease outbreaks and increase surveillance of potential biological threats more effectively [7].

III. TECHNICAL CONCERNS AND OPERATIONAL DIFFICULTIES IN THE EXISTING HEALTHCARE SYSTEM

Electronic health records are used to keep track of transactions, clinical workflow, and billing information[8]. Each patient's EHR information is collected at various points in time for documentation purposes. Age, gender, diagnosis and treatment, prescription drugs, laboratory results, radiologic findings, special conditions such as disorders, and administrative data such as insurance coverage may be utilised to modify. Every day, a significant amount of data is generated, exchanged, and examined in the clinical field of healthcare. Consequently, there are numerous opportunities for miscommunication and missing data. But this data is likely to lead to security and privacy breaches, and storing a large quantity of information is difficult and complicated. Free text is useful in routine clinical workflows, but it presents a significant challenge when it comes to automating workflows based on electronic health records [9]. Moreover, modifications to electronic health records may affect data quality.

Typically, interoperability necessitates multiple stages, including sending, receiving, locating, and utilising the data. The information and details regarding a patient's health care were dispersed across multiple organisations, systems, levels, etc. There is a significant difference between peer groups and healthcare organisations, and this is the primary issue or concern when it comes to providing quality health care. Due to the large number of individuals in charge of different aspects of the healthcare ecosystem, the process is not simple. Therefore, it is difficult to locate the necessary information when it is needed. To diagnose and inform clinical decision-making in healthcare and clinical settings, secure, dependable, and scalable data sharing is required.

The technique for sharing data is essential because it enables clinical practitioners to send clinical information about patients to the appropriate authority in order to make prompt decisions. So that each of them knows exactly what's going on with the patient and can take the right steps, the person giving the information and the person receiving it must do so in the most sensitive and private way possible. But because of the rules and regulations, the work is becoming more difficult and longer. With this method, it is impossible to provide the patient with proper medical care.In multi-site electronic health record-based registries, data access and privacy issues are complicated. Despite the fact that the patient is the owner of his or her own health data, hospitals are frequently reluctant to share their data with third parties. It is important to note that the data quality varies between the electronic health records used by various healthcare organizations. Sharing findings regarding data quality issues with data providers is difficult and may have legal consequences. Individual providers may be liable for inaccurate data collection. Data sharing is an additional concern for databases containing electronic health record information. Depending on the organisations involved, the rules for sharing identifiable or de-identified data vary, impacting the modification, preservation, upgrade, and ability to share such tools among healthcare providers, which remains a development challenge [10]. The majority of healthcare providers, particularly those with small branches, lack the workforce expertise to address all potential obstacles. By placing greater focus on the quality of the medical system, we may strive to provide the patient with
superior medical care.held

IV. BLOCKCHAIN TECHNOLOGY

Blockchain is a type of distributed ledger technology (DLT), which is a digital system for recording transactions and related data in multiple places at the same time. In a blockchain network, each computer keeps a copy of the ledger so that there is no single point of failure [11]. All records are updated and reviewed at the same time. It keeps records that make it difficult to breach the system or change the information it stores. This makes it safe and unchangeable. In reality, numerous sectors are now looking into blockchain-based applications because they provide a safe and affordable method for creating and maintaining a distributed database and keeping a record of all kinds of electronic transactions. Due to this, blockchain is now becoming more widely viewed as a way for multiple business entities to track and share data safely [12]. Blockchain platforms can either require permission to use them or not. Permissioned blockchains are private blockchains that can only be accessed with permission. A permissionless blockchain is one that does not require permission to join. There are numerous blockchain platforms, but Ethereum, Hyperledger Fabric, and OpenChain are three of the most widely used ones. Ethereum is a wellknown, open-source, and specifically designed blockchain platform that is thought to be the better choice for enterprise applications. Hyperledger Fabric is another blockchain platform that is free for anyone to use. It is made for permissioned networks and is used in fields like finance and manufacturing. Blockchain can also be used to host and store smart contract applications in a decentralised way. OpenChain is a platform for managing and storing digital assets that is based on blockchain technology. The rules for an OpenChain blockchain are set by the person in charge of the ledger. Then, if users follow the rules, they can trade value on the ledger.

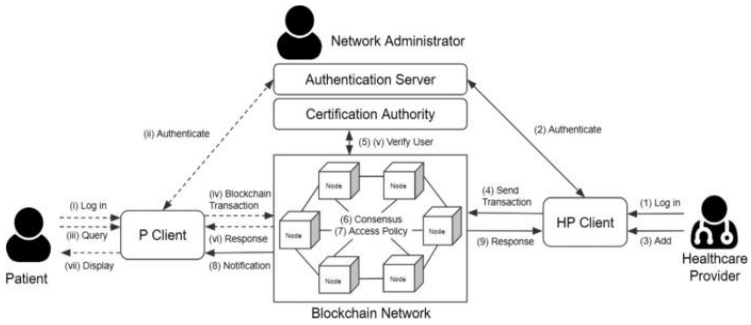
Blockchain technology is a must for managing the information in HER [13]. E-health and telemedicine are the two most important domains for getting an opinion from expert. The information is sent using online real-time clinical monitoring or a technology called "store and forward." The government, the community of healthcare providers, and the public health care system are all looking forward to the new opportunities that blockchain will bring. It's done by the FinTech industry, which has inspired others to do it in a way that could be more useful and has more potential. For future results, the industry should also put a lot of effort into setting up blockchain and building an ecosystem of partners to make it the standard or give it a boost so that it can be used on a large scale. The Hyperledger Foundation is the best example of a model for the healthcare space among the blockchain groups that are making the most progress [14]. This foundation is an open-source project that was set up to come up with new ideas for blockchain technologies that can be used in different fields. Smart contracts can let a patient use a token to share their medical information with research partners and healthcare providers. By using this method, the patient could also keep track of their health record online, just like they do with their bank account. This makes it easier for caregivers and healthcare organisations to talk to each other, which makes life better for all. The medical chain is working to make sure that the person's medical record is shared with the most important healthcare providers, such as laboratories, insurance companies, practitioners, chemists, and hospitals. All interactions should be safe, secure, and clear, and then they are recorded in the distributed ledger of medical chains.

IV. EHR MANAGEMENT USING BLOCKCHAIN

Blockchain technology has the potential to revolutionise the healthcare system by putting the patient at the centre of the system and enhancing data security, privacy, and interoperability [15]. This technology could provide a new model for health information exchange (HIE) by enhancing the efficiency and security of electronic health records (EHRs). Electronic health records (EHRs) contain crucial and sensitive personal data for healthcare diagnosis and treatment. These data are an important

source of information regarding healthcare. The sharing of healthcare data is a crucial component of creating a smarter healthcare system and enhancing the quality of care provided. Blockchain is a relatively newly developed technology with effective applications in healthcare. Smooth, efficient data sharing and delivery among all prominent network members and healthcare providers assists in the development of cost-effective treatments and advanced treatments for a variety of illnesses.

Blockchain-based personal health records (PHRs) are patient-centric applications[16] used for managing patients' data, who are the actual data owners, to access and manage it. Blockchain-based PHRs help patients monitor how the data related to their health is shared and used, confirm the accuracy of their health information, and help to correct any misinformation in their record. The significance of blockchain in healthcare is discussed further below with a case scenario. Figure 2 is an illustration of the system. Health records for each patient are encoded and kept on the blockchain. To communicate with the blockchain, such as updating the ledger and generating transactions, different users can access specialised client services. Figure 2 is a diagram that illustrates how patient health records can be encrypted and stored using blockchain technology. When users want to interact with a blockchain, such as by querying its ledger or generating transactions, they can make use of one of several different dedicated client services.



Source: Ref- [32]

Consider that all hospitals in X, Y, and Z cities in a country utilise the same distributed EHR system to track patient information. Consider a 40-year-old man who recently relocated to Y city for a new job from another country. He currently resides in Y city, but he has not yet registered with the healthcare system. Soon after relocating to the city, he began experiencing chest pain and discomfort. He visits the hospital for an evaluation and treatment. He completed his treatment and enrolled in the health system. He wishes to register with Y so that his treatment and care can be recorded and keep referring to in the future. During the registration process, the customer service agent will provide him with identification and document materials, which will be stored on a secure server. Among these were a symmetric key for quickly encrypting his records as well as a pair of public and private keys for sharing records. After receiving treatment and signing up, he gave permission to review and update his future medical records. This will allow the physician to record appointment information on the distributed systems. If a GP wants to add a report to his appointment, he must first sign in to hospital client care with his password and username. GP's information will undergo an authentication procedure, and if successful, the server will send back additional data (2). GP can utilize the medical provider user to perform a "Add Record" transaction after confirming the user's identity (3). This will create a record containing information about the medical diagnosis made during in the consultation.

During his annual leave, he travels to X city. However, he felt uneasy and rushed to the hospital for assistance. To help the hospital's physicians and nurses understand better his condition, he must agree to their viewing her medical record. The symmetric patient key is used to protect the entire record, with the exception of the record's identity and the entities (patient and HP) associated with it. Note that the healthcare centre could only obtain the patient's encoded symmetric key if the doctor consented. In addition to the encoded collect data, the transaction must include the smart contract's name ("add record") and version number. The hospital signs and transmits this agreement to any peer node in the network (4). When the peer node receives the transaction recommendation, it will verify the sender's identity by examining their digital signature (5). Once a predetermined number of planned transactions have been executed or a predetermined amount of time has elapsed, the network will initiate consensus protocol and send the eventually results block to the other network entities (6). Each peer node that received the block will independently execute each transaction using the contract mentioned in the transaction, in the exact order in which they appear in the block. When attempting to add data, the smart contract will execute the policies for access control to ensure that only authorised HPs can view or add documents for patients (7). Currently, each peer node will check the "permission list" for each patient, which is stored on the blockchain ledger, to determine whether or not the clinic has the patient's authorization to create

her medical records. This consent list includes the identities of all the doctors the client has agreed to see. The peer nodes will examine this list to determine whether or not it includes the title of a hospital. If the validation is successful, the record will be added. If particular transactions are committed, peer nodes may generate and transmit a "event" (8). Once the patient data has been successfully allotted, a peer node will notify patient client service about the new record (9).

These client services could be utilised by both healthcare providers and patients to transmit data to the blockchain. For instance, a patient who recently visited the hospital and wishes to obtain and review her records must first login in to his client customer services and verify her identification(ii). Then, he could even send a request to the department of client care to obtain her records (iii). The "View Records" request will be sent to network entities by the client service (iv). The peer entities will first verify the patient's identity (v), similar to the "Add Record" document, and then run the requests on their ledger to retrieve the patient's information and return it to the client (vi). Because content transactions do not alter the ledger, consensus is not required. After receiving the information from a peer node, customer service will use patient's symmetric key to decrypt the data and display them to the patient (vii).

VI. The Advantages of Blockchain in EHR

A. Keep information safe

The blockchain is based on existing cryptographic methods, such as an appropriate cryptographic structure for data sharing, to safeguard information. During clinical information, the health professional writes down the reference number, year of birth, diagnostic test results, treatment methods, and hospital outpatient history in electronic medical record format. This information is stored in the cloud or in existing databases. Before and after the various stages of a clinical test, a substantial amount of diagnostic and health data is generated. As a result, the information is compared to the blockchain system's original records [17],[18].

B. Analyze the results of a particular procedure

Researchers can study and analyse every type of procedure if they have verified access to patient data. This produces substantial results that enhance the treatment of patients. With the blockchain framework in place, the drug companies will collect real-time data to offer patients a vast selection of precisely tailored prescription medicines or services. Real-time data collected from wearable devices will inform clinicians of the patient's current condition and alert them to any emergency circumstances [[19], [20], [21]].

C. *Validation*

Transactions in a blockchain are validated using algorithms before being added to the chain. The content's authenticity is safeguarded until it is encrypted, validated, and stored. Healthcare organisations, technological innovators, and the medical industry are looking for ways to determine what they can do to make the system safer and more affordable now and in the future. When healthcare administration can adequately validate results, blockchain has the potential to revolutionise the health ecosystem [[22], [23], [24]].

D. *Security and openness*

Blockchain lets different parts of the health ecosystem stay in touch and share information across a large network. In such a system, users can exchange and analyse their data and other actions without the requirement for additional privacy and security measures. It gives better integrity and security while allowing doctors to devote more time to patient care. This allows for more precise diagnoses and more effective treatments [25].

E. *Maintenance of medical records*

Blockchain technology may be ideal for storing medical records. Its applications include the exchange of healthcare data, the maintenance of electronic health records, the management of insurance, and the execution of administrative duties. Digital blockchain contracts facilitate collaboration between sensors and intelligent devices. Using an app, patients can transmit

their health information to a blockchain network. Typically, electronic health records are shared between multiple care institutions. The blockchain will consolidate all data and grant patients access to historical information. The abundance of all this information in one location will yield new insights into the health status of a patient [26].

F. *Transactions*

In a blockchain, transactions are reviewed and approved by techniques before they are added to the chain. The authenticity of the material is secured until it has been encrypted, validated, and saved. The health ecosystem can be changed by block chain technology if the healthcare system can quickly and accurately verify the results.

G. *Develop research initiatives*

Blockchain can serve as a reliable information source. By facilitating a broader transfer of patient data, blockchain may facilitate better and more productive research initiatives. Moreover, the in-depth sharing of patient results will help enable more efficient and better studies and is likely to lead to an exceptional level of collaboration between participants and researchers. This technology may also assist with patient referral management. If a patient consults with a physician and develops a treatment plan, the therapy package will be added to the blockchain as part of the patient's medical record [27].

H. *Reduce data management time and expense*

Public blockchains reduce the time and cost associated with data management and restoration. Blockchain networks ensure that verifying the login details of medical professionals is straightforward and quick. Using smart contracts will lead to privacy-preserving datasharing networks that are of great value. Blockchain is a distributed computer network system that allows the recording of transactions and the verification of their timestamps. Each node in this entry stores all incoming data [28].

I. *Improves safety*

Blockchain makes patient care safer in general. It resolves the issue of drug validity and quality and enables the safe integration of diverse systems. This is the only way to change the current method of controlling the supply chain, prevent fake drug manufacturers from releasing their products, and enable various systems to work together in a secure manner. It might be the only method to replace the existing method of supply chain management and prevent counterfeit drug manufacturers from selling their products. Using blockchain, all information could be kept in a single location, regardless of the medical facilities or organisations involved. Due to the interoperability of blockchain technology with some other frameworks, doctors will have easy access to complete health records to help them determine what is really wrong and plan a more precise operation [[29],[30]].

The application of blockchain technology has been adopted to improve the traceability of patient health records across healthcare organisations while maintaining the confidentiality and integrity of patient data. Due to blockchain's decentralisation, data integrity, transparency, and traceability, the process of sharing and storing healthcare data can be enhanced [31].

VII. CONCLUSION

This paper explores how blockchain technology can benefit the healthcare industry and how it could be applied to electronic health records. Despite improvements in the healthcare sector and technological advances in EHR systems, they still encountered issues that were resolved by this revolutionary technology, blockchain. The use of blockchain to manage electronic health records solves the major issues of accessibility and authority. Because it is a decentralised system, only authorised individuals can access records from anywhere. However, many healthcare organisations are still hesitant to use blockchain technology due to concerns such as security and authorization issues, interoperability issues, and a lack of technical skills associated with blockchain technology. Because the individuals involved in the transactions can be identified, their confidentiality and secrecy may be questioned. Future advancements in blockchain will implicate data-sharing implementations that grant users control over their data. Users will begin "owning" their data and deciding who will have access to it. This will have an overall impact on healthcare.