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Blockchain: A Possible Alternative to Achieving Health Information Exchange (HIE)

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ABSTRACT- A patient may have access to one or more healthcare organizations, meaning that their health information is spread across separate EHR systems, resulting in data fragmentation. Thus, the medical history of a patient may not be complete, consistent or comprehensive if the records cannot be combined into a single consistent overview that may not be efficient for the future diagnosis of the patient. Health Information Exchange (HIE) relates to the electronic transfer of health care information between institutions and practitioners within a specific group, region or hospital. However, HIE is surrounded with various challenges such as data insecurity, threat to patient privacy, dependency on third parties and so on. Blockchain through its characteristics such as safety, privacy, decentralization, and immutability has the ability to transform health care, putting the patient at the core of the health care ecosystem, and enhancing health data security, privacy, and interoperability thereby offering HIE with excellent potential. In this paper Health Information Exchange (HIE) and Blockchain Technology are discussed and the possibility of using blockchain technology to achieve HIE is presented.

KEYWORDS- Health Information Exchange, Blockchain Technology, Health care, Interoperability, Security

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I. INTRODUCTION

Health Information Exchange (HIE) relates to the electronic transfer of health care information between institutions and practitioners within a specific group, region or hospital. In other words, HIE is the capacity according to global standards to adequately access and safely share health information of patients between distinct healthcare organizations (HCOs). The aim of HIE creation is to enhance the delivery of health care by providing reliable and safe methods of accessing and retrieving health information across various systems [1]. The exchange of data on health care (HIE) between medical organizations has been shown to be useful to the medical industry in latest years. First, HIE can improve each individual clinical trial's knowledge. Secondly, by evaluating a lot of clinical trials, the scientists can gain science insights. Third, the interoperability of health information between clinical research companies strengthens their partnerships [2]. However, HIE is surrounded with various challenges such as data insecurity, threat to patient privacy, dependency on third parties and centralized data storage. Conveniently, through its appealing characteristics such as safety, privacy, decentralization, and immutability, Blockchain technology, which began in 2008 and had acquired deep importance by 2014, offers HIE with excellent potential. Blockchain technology has the ability to transform health care, putting the patient at the core of the health care ecosystem, and enhancing health data security, privacy, and interoperability. By making electronic medical records more effective, disintermediate, and secure, this technology can provide a fresh model for health information exchanges (HIE). This paper therefore discusses Health Information Exchange (HIE) and Blockchain Technology and the possibility of using blockchain technology to achieve HIE. This paper is arranged as follows: Section One presents an Introduction to the study, Section two gives a brief overview of Health information exchange, blockchain technology and its application to healthcare is presented in section three and section four respectively. Section five describes how HIE can be achieved using blockchain technology while the conclusion is presented in section six.

II. HEALTH INFORMATION EXCHANGE

Health Information Exchange (HIE) relates to the electronic transfer of health care information between institutions and

practitioners within a specific group, region or hospital. In other words, HIE is the capacity according to national regulations to adequately access and safely share health information of patients between distinct healthcare organizations (HCOs). It includes institutions of health care and government, organizations of health information and skilled suppliers of health care. The purpose of HIE development is to improve healthcare delivery by offering reliable and secure ways to access and retrieve health information among diverse systems. It is an inherent part of the health information technology infrastructure as it aims to improve data gathering and medical care.

There are three (3) main health information exchange (HIE) methods, these methods are: consumer-mediated exchange, directed exchange, and query-based exchange [1]. Consumer-mediated exchange takes place by providing patients with access to their own electronic records, enabling them to track their health conditions, determine whether there are inaccurate billing or medical data, and update their self-reporting. Directed exchange takes place when a healthcare organization transfers vital information such as the results of the laboratory test and the dosage of medication to other specialists involved in the same patient's care. In unplanned medical care, query-based exchange usually occurs when a healthcare organization needs a new patient's previous health records. This is done by requesting access through the HIE system to these records [1].

HIE should therefore be performed with respect to privacy policies, strictly restricting access to patient documents to avoid any stranger from obtaining unauthorized access to the scheme. The data should be exchanged between organizations without leaking out of the scheme, which could happen due to the system's own faults or liability problems.

A. Benefits of Health Information Exchange (HIE)

The benefits of Health Information Exchange (HIE) are [3]:

a. Minimizes Medical Errors

HIE can ensure patient safety by reducing medical and medication errors, because data is securely stored in a database and shared through a digital channel.

b. Simplifies health monitoring

Simplifying the process of data exchange in healthcare improves health reporting and surveillance

c. Acts as a support tool

The HIE system acts as a support tool for doctors and health care providers offering support to clinical decision making for better treatment and effective care.

d. Eliminates repeated testing

In order to improve quality and results of health care, the HIE System eliminates unnecessary and redundant testing for healthcare workers.

e. Reduces cost

Efficient HIE systems can reduce health-related costs as they digitally supply information and patient data. Furthermore it also provides healthcare consumers with personal health information.

B. Security Requirements in HIE Systems

Security is essential when developing HIE systems. The following security criteria should be considered:

a. Authenticity and Authentication

The HIE system developer should guarantee that the specific information is accessed only by authenticated customers. Users ' credentials should be compared with the records of the database and, if they match, access may be given to the healthcare record scheme [4].

b. Non-repudiation

This is the assurance that somebody cannot deny their signature authenticity or message sent. One party, for example, cannot deny that a transaction has been sent or obtained. In order to achieve non-repudiation, digital signatures and encryption should be used.

c. Ownership of Information

The HIE system developer should consider the data proprietor in order to implement the required steps to safeguard against unlawful access or use of the medical data of the patient. The patient should be able to provide approval to the sharing of their health information with approved healthcare specialists [5].

d. Integrity

This relates to the information precision and consistency method. By using access control and encryption techniques, information should be protected against unauthorized tampering.

e. Confidentiality

This implies that data must be protected from unauthorized access. Only approved users should have access to data about health and identity. By using access control and encryption techniques, this can be achieved.

f. Availability

Where necessary, information should be accessible. The safety checks used to safeguard data and communication channels should be checked during design to guarantee that they work properly. Ensuring that data is accessible at all times makes decisions more effective [6].

C. Challenges OF Health Information Exchange (HIE)

Some of the common challenges associated with health information exchange (HIE) includes [3]:

a. Data privacy and security

Ensuring privacy and security of health data throughout the entire process of exchanging data is often a key point of pain for providers. Health care organizations, while also allowing data to flow freely as required for patient care, need to adhere to all data protection regulations [7].

b. Standards

Lack of consistency in the sharing of information on digital health may lead to some issues about privacy. To be used in EHRs, therefore, information exchanged digitally must conform to certain standards.

c. Patient Authorization

Patient consent is one of the most significant challenges in the exchange of health information as this is important to allow the exchange of health information across different technology and medical channels. Legal problems may arise if the patient's health information is shared without the permission of the patient.

d. Lack of universal identifier

When exchanging health information, it is difficult to match the patients to their health records. Owing to the existence of many patients with the same name, birth year, and living in the same city, providers find it difficult to match patients with the health records and share details. Therefore, an identifier is required which can match patients with their health records.

e. Competitions among health care organizations

Competition among providers exchanging health information is intense. Organizations are likely to keep on competing for the patient and to share information. The sharing of health information is the biggest concern among health care providers, according to the Harvard Business School report, and it is such that it has impeded the development of exchange of health information.

III. BLOCKCHAIN TECHNOLOGY

Blockchain can be described as a distributed ledger technology capable of recording safe and continuous transactions between parties. Blockchain fundamentally eliminates the need for intermediaries who were earlier needed to behave as trusted third parties to check, record and coordinate transactions by' sharing' databases between various parties. By enabling the transition from a centralized scheme to a decentralized and distributed system, blockchain efficiently releases information earlier stored in protected silos [8] At their basic level, they allow a group of users to record transactions within that group in a shared ledger, so that no transaction can be altered once it is published under the normal operation of the blockchain network. In 2008, to generate contemporary crypto currencies, the blockchain concept was merged with several other techniques and computational ideas: digital money protected by cryptographic processes rather than a central repository or power. Blockchain is not a regular database. This means that tables with rows and columns do not exist. Rather, a directory of previous activities exists [9].

IV. BLOCKCHAIN FOR HEALTH CARE

Decentralization is a significant characteristic of blockchain that obviously benefits healthcare applications, making it possible to implement distributed healthcare apps that do not depend on a centralized authority. In addition, the fact that the information in the blockchain is duplicated among all the nodes in the network creates an environment of transparency and openness that allows healthcare stakeholders, and patients in particular, to understand how their data is used, by whom, when and how. More importantly, altering any one node in the blockchain network does not affect the ledger's status as the information in the ledger is reproduced between several nodes in the network. Hence, by its design, blockchain can safeguard health information from future information loss, bribery or safety assaults, such as the attack against ransom ware [10]. Furthermore, blockchain's immutability property, which makes it impossible to change or alter any record attached to the blockchain, is very well aligned with the requirements for storing health care records— it is very important to ensure the integrity and validity of health records for patients. Moreover, the use of cryptographic algorithms to encrypt the data stored on the blockchain guarantees that they can only be decrypted by users who have legitimate data access permissions, thereby enhancing data security and privacy. In addition, since the identities of clients in a blockchain are pseudonymized by using cryptographic keys, patient health information can be shared among health care stakeholders without exposing patient identities. Blockchain also promotes smart contracts that can be used to program guidelines that enable patients to regulate how they share or use their health records [10].

V. ACHIEVING HIE THROUGH BLOCKCHAIN

The true value of interoperability could be unlocked by a blockchain driven exchange of health information. Blockchain-based systems are capable of reducing or eliminating present intermediaries ' friction and expenses. A significant aspect of solving the difficulties of system interoperability and accessibility of medical records is the exchange of Personal Health Records and Health Information Exchange (HIE) information through the Integrating Health Care Enterprise (IHE) protocol. While blockchain technology is not a magic solution for data standardization or system integration difficulties, it offers a promising fresh distributed structure to amplify and promote health care information integration across a spectrum of uses and stakeholders. It addresses several current points of pain and allows a more effective, disintermediate and safe system [11]. Due to the absence of common architectures and norms that would allow the secure transfer of delicate data among stakeholders in the scheme, the present state of health care records is disjointed and stove-piped. Every time a medical service is provided, health care providers track and update the common clinical data set of a patient. This information involves normal data, such as the gender and

date of birth of the patient, as well as distinctive information in accordance with the particular service given, such as the procedure done, treatment plan, and other notes. This data is typically monitored in a database within a unique organization or within a specified health care stakeholder network. This flow of information from the patient through the health care organization does not have to stop at the individual organizational level every time a service is performed. Rather, health care organizations could take further move and direct a standardized collection of data to a nationwide blockchain transaction layer in each patient interaction. Surface data on this transaction layer would contain data that is not Protected Health Information (PHI) or Personally Identifiable Information (PII); instead, select and non-personally recognizable demographics and services rendered data could provide access to an expansive and data-rich collection of data for health care organizations and study organizations. Information deposited on the blockchain could be widely accessible through the blockchain private key systems to a particular person, allowing patients to exchange their data much more effortlessly with health care organizations. This introduction of a transaction layer on the blockchain can assist to achieve the objectives of interoperability while establishing a trust-based and cooperative data sharing ecosystem to allow fresh perspectives to enhance the effectiveness of the country's healthcare system and its citizens ' health [11].

A. Toward blockchain interoperability

As a transaction layer, the blockchain can hold two categories of information: (1) "on-chain" data stored directly on the blockchain or (2) "off-chain" data stored on the blockchain with connections that act as a pointer to information stored in distinct, traditional databases. The storage of medical information directly on the blockchain guarantees that the information is properly protected by the properties of the blockchain and is immediately visible to those authorized to access the chain. On the other hand, encrypted links are minimal in size and enabled once a user with the right private key accesses the block and follows the encrypted connection to a distinct location that contains the data. For example, the blockchain cannot hold abstract data types such as x-ray or MRI pictures directly: connections to a different location would be required for this type of information. Frictionless submission and access to view information is needed to create interoperability. As such, the blockchain could function as a transaction layer for organizations to use one safe system to send and share information. This will be most efficient if a particular set of standardized information were to be stored for instant, permitted access directly on the blockchain, supplemented when needed by off-chain information connections. A standardized data set may include information such as demographics (gender, birth date, other data), medical history (immunizations, procedures), and rendered services (vital signs, services performed, and other data) [11].

B. Blockchain strengthens data integrity and patient digital identities

An interoperable blockchain can enhance information integrity while preserving digital identities of patients more effectively. Due to hacking / IT incidents, there were 112 million infringements of information on health care records in 2015. The intrinsic characteristics of public / private cryptographic important access, job evidence, and shared data in the blockchain generate a fresh level of integrity for health care information. Each blockchain-connected participant has a personal secret key and a public key that functions as an openly recognizable identifier. The pair is cryptographically connected in such a way that the private key can be used to identify in just one direction. Thus, one has to have the private key to unlock the identity of a participant to discover what information is useful to their profile on the blockchain. Therefore, the blockchain public / private key encryption system generates identity authorization layers to allow patients to share as-needed separate identity characteristics within the health care ecosystem with particular health care organizations, decreasing vulnerabilities resulting from storing PII on all sides and enabling patients or suppliers to introduce data access time limits.

C. Blockchain promotes friction-free connectivity, smart contracts and continuous access to electronic health information

Smart contracts can be developed in this interoperable blockchain to serve as a portal to store standardized data that can be instantly accessible to all blockchain-authorized organizations. This can be achieved by establishing intelligent contract based application program interface (API) architecture. The APIs will be released and made accessible to all member organizations linked to the blockchain— allowing for friction-free integration with current systems of each organization. When the API is activated, the contents of the patient communication will be transferred to the smart contract on the blockchain. Blockchain querying data can also be accomplished via a sequence of API calls that can be invoked by each linked organization. Organizations can instantly query particular blocks on the chain by invoking these APIs or provide specified query parameters (e.g. patients over 25 years of age). The APIs can supply a conventional portal accessing and using all health care organizations linking to their own devices for direct integration. The design oriented to the API enables organizations to continue focusing on their inner systems while requiring only redirecting particular information areas.

D. Blockchain enables Patient Centered Outcome Research (PCOR) and precision medicine insights

The blockchain transaction layer could allow a wealthy collection of standardized, non-patient recognizable data to be accessed immediately. As the number of participants in the huge cohort needed to advance precision medicine continues to spread, blockchain serves as the enabling factor without assuming accountability for the varied range of stakeholders for storage or information standardization. This data can be made accessible to research organizations and

current public projects and can be incorporated into the developing activities of the Precision Medicine Initiative (PMI) as blockchain deploys on top of or within cloud settings. Interoperability is one of the keys to accessing the strength of information intrinsic in a cohort of historical size, and both the quantity of information and the advantages of timely leveraging it can be exponential. This blockchain information set can be added to Big Data analytics and cognitive computing / machine learning to further evaluate the intersection of demographics, genetic markers, and a variety of other data. PCOR can harness the standardized data set to form its Data Access Framework policy and use the data to perform clinical research, reporting on patient safety events and identifying adverse events, and reporting on public health. In addition, owing to the privacy and security properties of the blockchain, PCOR scientists and partnering organisations can access a single source of data that retains the integrity of each patient's health care data.

IV. CONCLUSION

Health Information Exchange (HIE) is of utmost importance for doctors to have a consistent and comprehensive medical report and for patients' to get quality and effective treatment. There are some challenges surrounding HIE such as security and privacy, dependency on third parties and centralization, etc. that prevents it from been achieved. Blockchain technology through some of its characteristics and properties promotes the achievement of HIE. This paper therefore discussed the benefits and challenges health information exchange, blockchain technology and the prospects of achieving HIE using blockchain technology.

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