

Digital Transformation of Healthcare: A Blockchain study

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Abstract—Digital Health Trends (DHTs) are mainly driven by the need for quality patient care, easier and more reliable research and on-demand medical data access. With artificial intelligence (AI) the acceleration of advanced digital healthcare has started to grow and is expected to expedite further with the industry moving towards blockchain technologies. Blockchain is a distributed ledger system, which can be decentralized, encrypted. Initially built for crypto currencies and referred to most commonly, there are more and more applications outside of finance, many of which are significant for medical imaging. Besides the possible difficulties of implementation such as the public-private key access, distributed book size restrictions, speed and complexity, and safety defects. Potential cases of blockchain use particularly relevant for medical imaging include common images, including image ownership of a patient, tracking medical device, research, teleradiology, and AI. Blockchain technology creates great opportunities for complexity reduction, trust-free collaboration as well as secure and unchanging data. In this paper, we discuss the detail review on blockchain in healthcare, its advantages and disadvantages, application and working principle. We briefly discuss the challenges and their solutions on the basis of various technology which helps researcher in future direction.

Keywords— Digital Transformation of Healthcare, Blockchain, Healthcare, IoT, AR, VR.

I. INTRODUCTION

All over the planet, healthcare (HC) providers face a single challenge: the need for patient outcomes to be improved through cost-containing. Increasing demand for chronic disease management for the aging population, technological developments & the control of health care experiences by approved patients. A key component in addressing these challenges is the digital transformation (DT) of medical services by creating a rich foundation of health data and integrating technologies like the Internet of Things, advanced Artificial Intelligence (AI), machine learning & analytics. The method will lead to diagnostic improvement, prevention & patient treatment, allowing patients increasingly to utilize an evidence-based approach to make clinical preferences. Rather than interactions every few weeks, real-time interactions enable a physician to track a patient's "live." The effective use of HC resources & services provided by organizational intelligence ensures thus, elimination of costs. Yet efficient use of data by transaction transfers, legacy systems, fragmented data sources and restricted data standards adoption, technological debt, data security and privacy concerns for all of HC's stakeholders. This has contributed to a highly regulated, small industry. Ultimately, the goal is to improve the quality of life & save lives by creating a

Professional HC provider that offers value-based HC and seamless patient experience. Information technologies that allow this objective should be extensible, secure, reliable & accessible & tailored to individual organization's digitization maturity level [1]. The main aims & objectives of the digital transformation of Healthcare are:

- Build a decentralized ecosystem of HC through real-time peer-to-peer communication.
- To protect data security & privacy.
- To improve medical care in a large part with the help of blockchain.
- To provide enhancements in prevention, patient therapy & diagnostics.
- To enhance the quality of life & to save people's lives by creating an intelligent HC provider.
- A seamless experience for patients and HC based on value.[2]

A. Digital Transformation in Healthcare in 2020: 7 Key Trends

The beneficial effect of technology on health care is the digital transformation of HC. Telemedicine, IA and

electronic health records are just some specific instances of DT in HC, and blockchain electronic health records.[3]

Here's a clearer description of HC's DT position in 2020:

1) *Telemedicine*

Over one million telehealth patients were registered in 2015. By 2018, that number rose to 7 million—and for good reason. Tele sanitary technologies today enable patients to access high-quality healthcare and to obtain life-saving diagnoses even in the most remote locations worldwide. Can't allow top cancer specialists to fly around the country? It does not matter. This specialist may connect digitally with your local doctor so you never miss a beat in your treatment. In a sense, telemedicine levels playing field—financially & geographically—allowing anyone to access the best healthcare at any time.

2) *Artificial Intelligence (AI)*

AI simplifies patients' lives, doctors & hospital administrations by carrying out tasks usually carried out by people but at a fraction of cost & in less time. AI is one of the highest-growth industries in the world and is estimated to reach \$150 billion dollars by 2026 by some 600 million dollars in 2014. Whether it is used to find new links between genetic code or to drive operational robots, AI reinvents and revitalized modern healthcare by means of machinery that can predict, comprehensively learn & act.

3) *Blockchain*

Medical blockchain is a system that provides patients with their own detailed personal medical data, ensures safe & reliable storage & sharing of health information among patients, medical institutions & third-party providers in the system. Medical blockchain's ideal characteristics involve patient ownership, safekeeping, privacy, manipulative & convenient interoperability. Health blockchain provides a distributed & open way of storing & handling medical data.

4) *AR and VR*

AR (Augmented reality) is used by more life science firms to bring new technologies into life, merging virtual & physical environments. AR helps to create rich interactive experiences that demonstrate the interaction of medicines & medical devices with the body. Brand teams & content providers may use this disruptive technology to better engage healthcare professionals (HCP) in their field. AR can also make HCPs more illustrative when illustrating new medications to patients. AR & VR (Virtual Reality) is not the same, although they are often combined in discussions. AR is incorporating real-world virtual objects. VR, by comparison, is a virtual world immersive experience.[4] The use of specialized hardware, headsets & learning curves is also considered less cumbersome than VR. Conversely, AR appliances operate at common devices like iPads to create a learning experience with no additional equipment, by integrating spatial & sensorial feelings. Most specifically, AR is more and more available on smartphones to gain popularity over VR Industry analysts conclude that Apple's AR Kit, as well as the AR Core software of Google, has encouraged developers to build more AR applications for mobile devices that will increase their use of ARs sharply. And by the end of 2019, eMarketer projects will use AR for almost 70 million people in the US.

5) *Digital Twin*

Digital twins: The link between physical and digital worlds by the Digital twins. They were utilized to create exact models of environment that are as dynamic as the physical environment, using computer systems & industrial technology. For healthcare, a Digital Twin provides a secure environment for providers & manufacturers, by testing in a virtual (person/ device) system version that is driven by abundant data from the actual system, to check the effect of a possible change on HC process.

6) *Wearable and the IoT*

In recent years, as a result of advances in IoT, several wearable devices moved from the wellness segment to real-time patient monitoring [38]. The costs of sensors have fallen, open-source libraries have become more available and engineering frameworks have become integrated and application programming Interfaces (APIs) have been reduced. People with near monitoring conditions can use a wearable device for the routine monitoring of important health indicators. Patients may communicate their data with their health professionals with the help of wearable devices so that doctors understand their conditions in greater detail. For example, Cloud-DX Vitality, Cyncadia Health, Google Smart Contact Lenses, Chrono Therapeutics Smart Stop, etc. are all wearable assistive as well as diagnostic devices. We now

confer trending technology of Healthcare's digital transformation that is, Blockchain.

The remainder section of the paper is structured as: Section 2 defines the literature survey on Blockchain in healthcare. Section 3 gives a detail review on Blockchain in healthcare, its architecture, working principle, their

advantages and disadvantages, application of blockchain in healthcare. Section 4 comprises the challenges of blockchain in healthcare and gives solutions of blockchain in healthcare on the basis of existing technology which is useful for future perspective. Section 5 concludes with future research direction.

II. LITERATURE REVIEW

Sudeep Tanwar et al. [2020] Some methods are examined, including frameworks as well as tools to measure the performance of such systems, for example, Composer, Hyperledger Fabric, Hyperledger Caliper, Wireshark Capture Engine as well as the Docker Container, for improved healthcare systems using blockchain technology. In addition, the papers suggest an access Control Policy Algorithm designed to increase data accessibility among healthcare providers, helping to simulate environments to introduce a chain code model sharing the Hyperledger-based Electronical Healthcare Record (EHR) system. In blockchain networks, performance metrics like throughput, latency, RTT (Round Trip Time) have also been optimized to produce better results. The proposed system uses blockchains to improve efficiency and security in comparison with traditional EHR systems using client-server architecture. [5].

Prateek Pandey and Ratnesh Litoriya [2020] To evaluate social & technical challenges facing the delivery of comprehensive health care services on a large scale and propose a technological solution to serve society as a whole. This study examines the initiatives of India's National Health Policy (2017). The social and technical barriers are discussed and Aarogya Chain, a technology-based Blockchain solution to eliminate hiccups in the implementation of health policies, is being proposed. In the implementation of blockchain health services on such a large scale, scalability is the main concern. We experimented with a blockchain & found that system throughput is dependent on no. of special nodes named ordering nodes, and a compromise is required to balance time- to-commit tolerance as well as system tolerance [6].

Fakhri Alam Khan et al. [2020] Developed on various important aspects of Blockchain technology, such as its working mechanism style, possible suggestions for improvements using proof-of-stake, and other customized variations to try out seven challenges with different new techniques. Furthermore, we explained current state-of-the-artwork in non-financial applications such as Healthcare for blockchain in which the contribution of four levels of custom blockchain models was remarkable. In addition, a mobile app model known as HDG was a major contribution to automating medical records without compromising privacy. [7].

Anton Hasselgren et al. [2020] The purpose of this study was a systematic review, evaluation as well as synthesis of publications that are reviewed by peers using/proposing blockchain to improve health care, health science as well as health education processes & services. In October 2018, a

structured literature search was performed for a topic. The inclusion criteria were met by 39 publications. The result shows that EHRs and personal health records use blockchain technology for the most target areas. Access control, interoperability, origin, and data integrity are all problems that blockchain technology is intended to improve in this field. The fabric of Ethereum & Hyperledger appears to be platforms or frames most commonly used. This study illustrates an exponential increase in efforts made to use blockchain technology throughout the health field. Some areas in the health domain may be greatly affected by blockchain technology [8].

L. Hirtan et al. [2019] present the system's design for use in the healthcare system through blockchain technology, in which essential information on medical outcomes is shared among hospitals, medical clinics & research institutions based on patient-defined access policies. Our solution involves two kinds of chains, a private one, the side chain, to protect confidential data. Experimental results suggest good system efficiency in relation to (1) time to classify medical data for a specific patient; and (2) time to distribute all blocks through the peer-to-peer networks [9].

Abdullah Al Omar et al. [2019] to ensure privacy introduce patient-centered data management system with blockchain technology. For encrypt patient data and maintain pseudonymity, crypto graphing functions are used. We analyze data processing as well as the cost-effectiveness of our system's smart contracts utilized in our system [10].

A. Devibala [2019] presents a comprehensive overview of existing IoT systems blockchain customs. This starts by outlining blockchain & delineating current tests by blockchain progression [11].

Luca Brunesea et al. [2019] propose a mechanism for preserving data exchanged in hospital networks, in particular about magnetic resonance images (MRI). Every host network should validate the data transiting network as expected from blockchain technology. We use formal equivalency checks to perform this validation through the automation of MRI through exploiting radiomic features [12].

Minh Nguyen Dang Tuan et al. [2019] this implies the approach of a startup in the field of healthcare to construct a business model. Patient big data, safety facilities, and devices, hospital and laboratory information

systems are the main problems in the healthcare sector (Wang et al. 2018). The IoT trend in various industries together with other high technology like big data & AI attracts the business community's attention in Vietnam. IoT and big data are now able to enhance business models of data analysis companies that are looking to provide healthcare entities with a similar service at a lower cost. Eco medic medical systems should, therefore, develop their delivery network to improve service dependence, preventive dispute management and patient orientation for private and public healthcare organizations in Vietnam. [13].

Gautami Tripathi et al. [2019] one of the most common cases of IoT as well as its related technologies have been a domain of healthcare. But its wide widespread adoption remains a distant dream. The main reason is data as well as participating entities' security & privacy. In order to overcome this, blockchain technology has become a convenient way to

Partha Pratim Ray et al. [2019] Advocate for an important role in disseminating overwhelming increased user experience in connection with IoT of industry standards as well as edge computing components. First of all, we add taxonomic classifications and look at industrial aspects that can benefit from the IoT scenario and the edge computing scenario. Furthermore, two practical applications recently used edge- IoT paradigms to work together to address clever urban living problems. Second, we propose new e-health architecture based on edge IoT. EH-IoT & developed a demo test-bed. Promising results showed that IoT Cloud Analytics or storage facilities are not dependent on the results. We conclude by discussing various parameters of incorporation of edge-IoT ecosystems, such as architecture, demand capacity, functional issues & section criteria [15].

Thomas McGhin et al. [2019] Technologies from Blockchain will lead to some of the problems of the health industry. Applications that have been highly researched: protection, decentralize honesty, availability and automation on a general ledger & block-related infrastructure are the main healthcare environment potential for blockchain technology. The health care sector is struggling to adapt to an expanded technological infrastructure that relies on Internet-activated devices, IoT, smart devices and sensors. Since many technologies allow the healthcare industry to support its patients in an increasingly interlinked environment, malicious actors can also take advantage of the vulnerabilities of these technologies (even users & processes) to access and duplicate data. This could lead to outdated data and therefore an issue of safety or misdiagnosis and a patient identity check. It is clear that a range of current healthcare concerns in blockchain technology can be tackled based on the literature reviewed in this study [16].

Lena Stephanie and Ravi S. Sharma [2019] The epochal review of research literature on practical digital health ecosystems that emerged during the period between 1998 and 2018. Practice guidance applies to initiatives that have had positive effects on the provision of health care & transitions. This review is mainly aimed at tracking the development of digital health as well as visibility-crucial steps to gain an understanding of important issues relating to healthcare delivery. This work discusses these different key concerns and the idea of sensitization in general. Therefore, sense-making illuminates' fields of investigation central to understanding the paths of medical practice. Those research areas were often referred to as "substantive fields" for quality- oriented research jargon with "electronic records," "healthy clouds," "data analysis," "Internet apps," etc. The study concludes with a list of the key findings from the epochal review. Digital healthcare disruption has provided a digital, interoperable service providing the necessary conditions. [17].

Koshechkin et al. [2018] Blockchain are defined as technology to be used in closed systems to register public healthcare official data. Its technology has also been used in various other ways, e.g., medical staff education, management of healthcare contracts. And Blockchain has suggested the role of CALS / PLM technology [18].

L. Mertz [2018] Digitized patient data may be available for EHR but obtaining this information from one clinician to the other is still a huge challenge, especially since patients are often tested, prescribed and therapied by multiple doctors. Most experts are now convinced that blockchain technology can only be the way to obtain relevant medical information from a patient to the location it is needed and allow patients to view their own medical history easily. However, blockchain technology may help with other aspects of health care, including enhancing insurance claims or other administrative processes within health networks & providing biomedical researchers with population-related health data [19].

W. Liu et al. [2017] describes the new system solution to provide a reliable mechanism for secure & efficient medical record exchanges in our Blockchain Architecture. The ABC (Advanced Block-Chain) method was designed both for healthcare growth and new forms of social interactive norms. The Advanced Block-Chain approach was adopted. E-Health industry will be revolutionized more efficiently by eliminating many of the intermediates we know today [20].

S. Hussain and S. Lee [2015] Due to the comprehensive nature of health analysis experts, health standards are complex & hard to understand. This research aims to address in a distributed environment the voluminous data

and complexity of the semantic transformation model for health documents. Hadoop is used for the semantic transformation model and clinical documents architecture (CDA) framework in the case study here. The case study illustrates that health research may be assisted conveniently and customizing by the transformation model. [21].

Medical data (MD) store system uses secure storage & sharing cloud storage & blockchain technology as shown in Fig. 1. Three primary exchange bodies are government agencies and patients & third parties' organizations (like medical data providers & medical insurance firms, etc.) in the blockchain. The framework of blockchain medical services is shown in figure 1. Medical institutions are accountable and responsible for medical diagnosis and treatment. Patients visit a doctor and indifferent medical institutions have ownership & control of personal medical records. Agencies of the third party that offer different services such as referral and registration of appointment of medical establishments. Most forms of transaction companies have several permits.[23]

Key transactions in medical blockchain are data storage & access control. It will be ideal if all medical data can be stored on a blockchain, but only index data from medical data & transaction records are collected on blockchain given practical limitations such as costs, storage capacity. Large health data could be encrypted & stored outside the blockchain. Such medical details are stored in our cloud storage chain network. Access Control is specified through consent, as are various transaction entity permissions. The right to utilize personal medical data is completely controlled via a patient in a medical blockchain. A patient may also obtain his permission in due course. The medical blockchain generates building blocks. First validation of anew created blocks through network nodes & then added to the main chain to permanently preserving transaction data. Timing is to ensure that blocks follow the timing link for the medical blockchain. Blockchain data were not manipulated with the hash function, and the verification of identity can be accomplished using public coding. Both innovations combine to ensure safety and security for the medical blockchain.

III. BLOCKCHAIN IN HEALTHCARE

In order to amplify & encourage the integration of health data into a diversity of uses & stakes, Blockchain provides a promising new distributed framework. In the health sector, the specific benefits of Real-time recordings & blockchain manipulation resistance can be expressed. Data collected in a blockchain may be shared between individuals & organizations in real-time. Each transaction or even is time-stamped to be included in a long chain or enduring record which may not subsequently be manipulated. Entirely parties may assessment all records on an unauthorized blockchain. Data protection may be assured on a blockchain by agreeing where to check for transactions, and by whom to cover both parties ' identities. Therefore, the blockchain transforms multiple information a single owner holds into the whole asset history. There are various health care possibilities for Blockchain technology, but currently, it is not a full-fledged technology or an imminent implementation of a panacea. Personal medical and service- based patients are still to be handled on the basis of blockchain technology. [22]

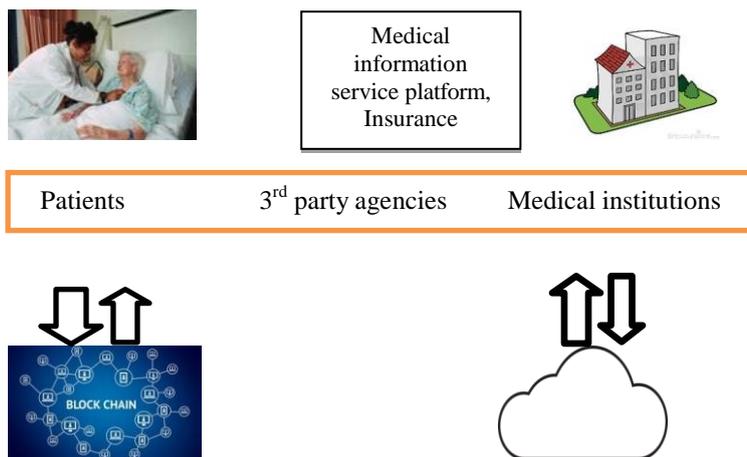


Fig.1.The architecture of Medical Blockchain

In a medical blockchain, important roles are issue, preservation & medical data sharing.

- **Medical data release (MDR):** When a patient goes to a medical facility, the doctor creates medical records or test results for the patient. Once medical information is generated, after entering the issuer's private key, the doctor generates digest & hash-medical information and sends this to the blockchain. At the same time, medical data codes are encrypted with symmetrical keys &

encryption of the medical data protected via a public key. Both of us are sent to the patient together.

- **Medical data storage (MDS):** The patient verifies the signature of the institution after receipt of the data by the medical institution. He uses a private key to decrypt, an encryption key for medical data, signature, and original medical data & generates a new encryption key to store medical data & a cloud signature.
- **Medical data sharing:** User himself may allow a third-party entity, through the access control system, to access some of its medical data and may also revoke its consent at any time. The shared storage data, rights of use and expiry date of the third-party agency decryption key and cloud storage management will be written into the medical blockchain. Recently, there has been a significant interest in the use of blockchains to supply safe healthcare data, exchange biomedical and e-health information, brain simulation, & thought. Blockchain is accompanied by a P2P network. This primarily comprises P2P multi-field network architecture consisting of algorithms, cryptography, and math to overcome the limitations of conventional distributed database synchronization using algorithms of distributed consensus. Blockchain technology primarily has six key features: transparent, decentralized, autonomous, immortal, anonymous and open-source technology.

A. Key components of blockchain technology

- **Decentralized:** Database system with open access control system for any person connected to the network. Multiple systems may access, monitor, store or update data.
- **Transparent:** For potential users, the recorded & saved data on a blockchain is transparent and easy to update. Blockchains' transparency should certainly avoid data being modified or stolen.
- **Immutable:** Once stored, records will always be stored and not easy to modify without control of over 51% of the node simultaneously.
- **Autonomy:** Blockchain system is autonomous & independent, allowing each blockchain system node to access, transfer, and store & updates data securely and free of outside interference and trust.
- **Open Source:** Blockchain technology is designed to allow access to the open-source for all network-connected persons. This irreplaceable versatility not only helps everyone to review documents publicly but also to build numerous imminent applications.
- **Anonymity:** When data is transferred among nodes, the individual's identity remains anonymous and therefore makes it a safer and more reliable system.

Every new transaction made must be checked by an individual in this network. When every transaction is verified by all nodes in a network on a block of a blockchain, it becomes increasingly unchanged. The following diagram shows the blockchain workflow in healthcare (as illustrated in Fig. 2) [24].

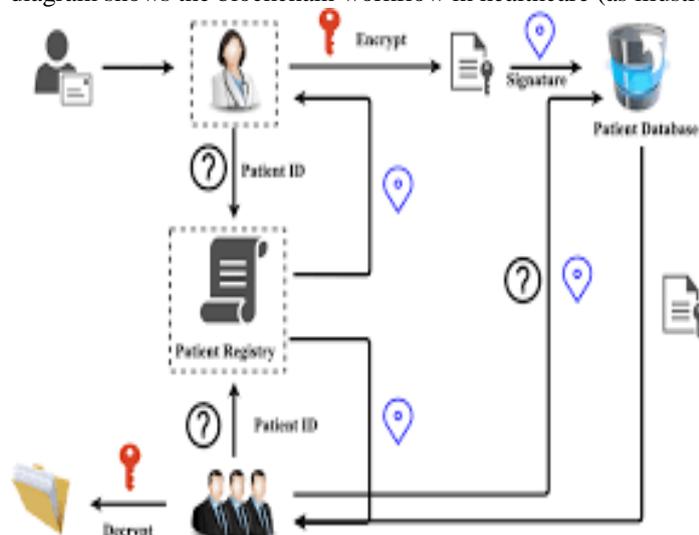


Fig.2.Generalized workflow of the blockchain process

B. Application of Blockchain in Healthcare

BCT (blockchain technology), however, its application in some sectors, including the biomedical fields, has been aimed at its most popular completion in economics and crypto currencies. The technical potential of Blockchain is demonstrated by its mechanism for stabilizing and securing data set that allows users to communicate with the certain genome, medicine, monitoring, neuroscience, e-health, telemedicine, & personalized healthcare transactions.

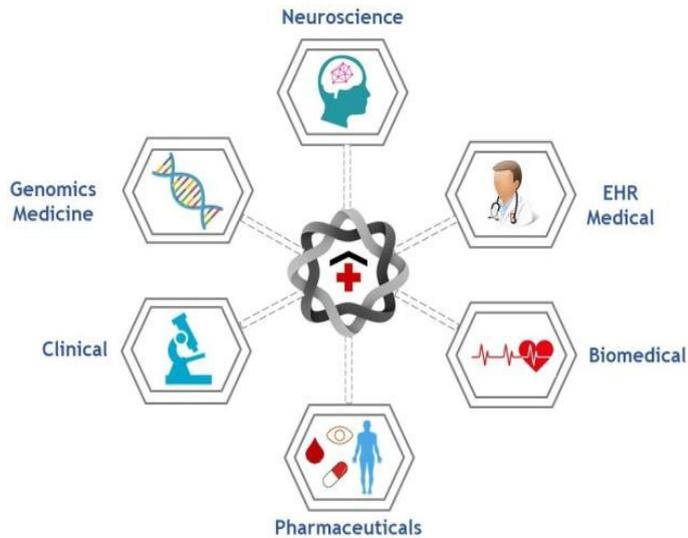


Fig.3. Application of Blockchain in Healthcare

- **Electronic Health Records:** The incorporation of EHR software into a centralized blockchain directory from data generation to data recovery point without human intercession is assured.
- **Clinical Research:** Blockchain introduced a decentralized secure framework for all possible clinical research information collaborations. This allows data to be shared securely with research groups.
- **Medical Fraud Detection:** Blockchain, whose feature is permanent, helps identify fraud and ultimately makes a transparent and secure transaction by not allowing replication or alteration of a transaction.
- **Neuroscience Research:** As an invention, Blockchain brings several future applications involving brain enhancement, brain reproduction, and brain thinking. It clearly requires a platform to store the whole human brain and here blockchain innovation lifts its head.
- **Pharmaceutical Industry and Research:** Blockchain monitors each of the pharmaceutical supply chain stages using its power of detailed traceability: Medicine origin, its constituents, and ownership are often identified at every stage to prevent forging or stealing of goods. [25]

C. Working Principle in Healthcare

Blockchain technology redefines data processing and management in many health applications. It has unparalleled safety and sharing of medical data & resources due primarily to its segment adaptability & ability. The focus of many of today's healthcare technologies is on blockchain technology. Innovative blockchain healthcare technologies are conceptually classified into 4 categories, namely data sources, blockchain Platforms, healthcare applications & stakeholders. New opportunities are being provided by advances in the fields of electronic medical data, the protection of cloud data and privacy regulations, the management of health information and the easy access and

exchange of patient information. Ensure, store, transact and manage their smooth integration is extremely important for any data-driven business, especially the healthcare sector, where blockchain technology can tackle these critical challenges robustly and efficiently. The blockchain technology is attracting tremendous interest from individuals and organizations of almost every kind & dimension. This is able to transform traditional industry using its features, which contain anonymity, decentralization, suitability, & persistence. The high-performance team is now widely known as an essential tool for creating a more patient-centered, integrated & effective health care system. The healthcare industry is an important part of the medical billing process. This is because the right quality of service cannot be assured without billing. The treatment starts when the patient is admitted into the hospital during the check-out phase [26].

D. Benefits and Drawbacks for healthcare applications of blockchain

In this section we focused on the benefits and drawbacks of blockchain in healthcare as shown in Table I and Table II. Also give a brief description of advantages and drawbacks of blockchain in Healthcare.

Table I: Benefits of blockchain in healthcare application

Advantages	Description
Improved data security & privacy	Blockchain's immutability improves greatly the security of health data stored thereon, as it can't damage, alter, or retrieve once saved in the blockchain. All blockchain health information is encrypted, timed and chronologically connected. Health data are also stored on blockchains using cryptographic keys that help protect the patients ' identity or privacy.
Health data ownership	Patients must possess their data & control the use of their data. Patients need guarantees that other parties are not misusing their health data and should be able to detect such abuse. By using powerful cryptographic protocols and well-developed smart contracts, Blockchain helps to meet these requirements.
Availability/robustness	Because the records are replicated in several nodes on a blockchain, access to the stored health information on the blockchain is assured since the network is robust and immune to data breaches, data corruption & security attacks on data accessibility
Transparency and trust	Blockchain establishes an atmosphere of trust in distributed healthcare applications by its open and transparent nature. It makes it easier for health workers to consider these applications.
Data verifiability	The integrity and authenticity of these documents can be checked, even without accessing the plaintext of the records stored on a blockchain. This is useful in areas of health care where documents such as the management of the medication supply chain and evaluation of insurance claims are to be reviewed.
Decentralization	There must be a decentralized management system in the very nature of healthcare, in which distributed stakeholders exist. Blockchain can be a decentralized backbone for health data management that allows all stakeholders to access the same health records controlled, without any central authority playing the role of the global healthrecords.

Table II: Drawbacks of blockchain in healthcare application

Drawbacks	Description
Data Ownership	Who's going to own medical information? Who is going to give the sharing permission? That kind of structured department or procedure has not been established yet.
Cost	The costs of developing and keeping blockchain health care are not clear, and without understanding the costs in advance none can take the technology seriously.
Rules and Regulations	In the healthcare sector, blockchain use is not limited. It is also not clear whether new healthcare blockchain initiatives can comply with existing privacy regulations, such as the HIPAA Act.
Uncertainty	The Blockchain definition has not been widely used and, based on this modern technology, there are currently only a few active initiatives. This is a big obstacle since we don't need to follow many good unstable blockchain models.

IV. CHALLENGES AND SOLUTION OF BLOCKCHAIN IN HEALTHCARE

Blockchain is an emerging technology that has a wide range of benefits and opportunities in different sectors. This technology does, however, have its own series of challenges to face as shown in Fig. 4.

1. Privacy & Security of Data

In the event of an emergency, a patient must choose one or more representatives who may, on their behalf, access his details & medical history without the permission of the third party. The agent may now also permit a group of people to access records of a patient that poses an enormous threat to the privacy and security of information. The introduction of high-security mechanisms in data, in effect, would make it difficult for users to access restricted or incomplete data transmissions block by block. Blockchain networks are potentially vulnerable to a type of security breach called a 51% attack. This attack involves a team of miners with a network of more than 50 percent blockchain. A network authority is given to miners and can prevent any additional transactions by not granting consent. 5 crypto currencies have experienced this recent attack, as per CoinDesk, in addition, a patient record may have sensitive, improper data.

2. Managing Storage Capacity

The management of storage capacity is another problem. Blockchain has been developed to store & process transaction data that are of a restricted nature so that heavy storage is not required. With time, the storage challenges became obvious as they spread their wings across the healthcare domain. In the healthcare sector, a great deal of data must be handled every day. All of the data is available for all nodes of the chain, from patient records, health history, and trials to the X-rays, MRI scans & other medical images, in the blockchain scenario. All of them are available. Blockchain applications are also transactionally based, and the databases used for this application are therefore that quickly. The level of record search and access is lower with the rise in the database size, which is very unacceptable with respect to speed transactions. A scalable and robust blockchain solution must, therefore, be sought.

3. Interoperability Issues

Blockchain also suffers from the issue of interoperability; i.e., having blockchains communicate with each other flawlessly and correctly by several communication providers. This challenge impedes successful data sharing.

4. Standardization Challenges

Blockchain technology still is early and is likely to face obstacles to medical and healthcare standardization. The international standardization authorities would also create a range of well-authenticated and certified standards. These pre- defined standards could help determine information exchanges in blockchain applications, their size, data nature as well as format. Such requirements not only evaluate data shared, but should also serve as safeguard measures [28].

A. Several Technology Solutions for healthcare available in Blockchain

Blockchain has various advantages and opportunities nowadays in Healthcare. Here we discuss some technology that already exists and gives the best proposal in advancement in Healthcare using Blockchain technology in Table I on the basis of its description and outcomes.

Table I: Several Technology Solutions of Blockchain in Healthcare

Technology	Description	Outcomes
Burst IQ [29] (2015)	They provide several services, mostly data-driven platforms based on blockchain healthcare. They provide the user with an ecosystem for data management. With user data, they develop individual life graphs as well as store them in a healthy wallet. User is able to manage, share, sell as well as supply individual information.	Burst IQ offers an interactive platform for the distribution of large data between individuals, researchers, and organizations. It complies, and encourages a greater amount of health data, with HIPAA, GDPR & NIST compatible. Also, for big data processing Burst IQ uses machine learning.

MedRec [30] (2017)	MedRec offers a full platform for the authentication & sharing of patient data between stakeholders. They utilized PoW (proof of work) mining to create support among researchers, public health officials & patients. Incentives focused on efficient data sharing and authentication have also been introduced. It offers a simple audibility log for data sharing. In co- development of a blockchain platform named "MedRec," MIT Media Lab & Beth Israel Dracones Health Centre,	In current situations include breaches of the Data Infringement Code and other possible crimes in connection with health-care data including confidentiality and authentication. MedRec is intended to comply with the necessary requirements. It stores health data in a different way than conventional ways to store data in HER.
Gem Health [31] (2016)	This US-based blockchain company's main aim is to handle income generated from data acceptance and sharing.	The main aim is to expand the gem's solution in medical sector
Guard time [32] (2007)	This is the first blockchain company in the world. Estonian blockchain service. In order to bring transparency & audibility to patient records, they joined the Estonian eHealth Foundation recently.	Oracle used this tool to handle electronic patient information from the government and blockchain databases.
Health Combix [HC][33] (2016)	This platform's main purpose is to create a decentralized ecosystem in real-time through PP communication. HC is a patient data management platform based on token privacy.	This framework promotes the prediction of large data study-based diseases and open risk- related monetization of assets. In this study, a private blockchain is used to create a research collaboration framework.
IBM Blockchain [34] (2016)	IBM also provides many healthcare facilities with other blockchain applications. The main factors of IBM blockchain in healthcare are automated trials and open exchange of health records	It is fast, flexible and grow blockchain solutions and built for multicloud world.
Universal Health Coin [35] (2017)	A decentralized crypto-currency and AI analysis for Gordon stakeholder data exchange. The device user will communicate directly with each data owner and processor in order for data to be purchased and sold by the UHC coin	All transactions & data are authenticated via public-private blockchain & secured.
Genomes [36] (2018)	Genomes deliver a platform for safe sharing between third parties of biological information. This research implemented GENE tokens as an exchange medium.	This technology empowering the genetic data and advance sequencing technology, genome cloud analysis platform and secure data encryption.
Youbase [37] (2018)	Presented a wallet based on HD (hierarchic deterministic). The wallet handles access to personal data and has a central structure like a tree. A major benefit is that, depending on the specific information type, this Youbase will store data separately because it has many branches (parent or child chains)	To comply with data protection laws, the process of data anonymization is used.

B. Future Perspectives

The medical industry will benefit from Blockchain technology with many advantages. Likewise, the internet revolutionized medical care & implemented telemedicine by reducing the cost of data analysis, setup & central server management and medical information, Blockchain technology will likely lead to the future of medical science. The use of clinical blockchains dramatically reduces processing times, as the full data collection is available as soon as a patient is enrolled in a trial, despite the transparency on transmitting

ledger. In fact, doctors are not worried about giving the patient an accurate medical history because of their ability to see original, true, and reliable data in real-time. Similarly, patients will not need to think about another doctor's second opinion due to data transparency. Most people in the world have patient records in a network of blockchains that can help patients to feel accepted, encouraged, and reinforced in their willingness to fight the disease and have a link with similar conditions. Patients are completely autonomous and decide with whom they can share information. Overall Blockchain has potential that increase the range in healthcare and give new direction in research field.

V. CONCLUSION

Blockchain's technology will change healthcare, put the patient at the center of the healthcare ecosystem & improve health data protection, confidentiality & interoperability. This technology could provide a new model for HIE (health information exchanges) through more efficient, disintermediated & secure electronic medical records. In this work, we analyze the digital transformation in health care in terms of blockchain and define its pros and cons and some applications of blockchain. Although very new technology, its applications in the financial sector have increased exponentially and have been applied to other industries such as medicine. Blockchain technology offers unique chances of reducing complexity, facilitating trustless cooperation and secure and unchangeable information. An approach based on blockchains will exploit encryption to verify patient identity and also improve data probity. Licensed users who may add—but not delete or change—transaction logs are able to share Blockchain records. Blockchain ensures encryption of all transactions and network testing. In this report we mainly focus on detailed review of Blockchain in healthcare, its challenges and also discuss the solution of blockchain technology in healthcare which is understandable for future prospects and develop fully fledged medical data storage and sharing.

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