AN ANALYSIS OF BLOCKCHAIN TECHNOLOGY USAGE IN GLOBAL HEALTH SYSTEM

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ABSTRACT: A reliable and secure Blockchain-based method for capturing and transmitting private health information is described in Blockchain in Global Health: An Assessment of Its Current and Future Applications. This paper aims to summarize current applications of this technology in the realm of global health and speculate on its potential future applications. Using the United Nations' Sustainable Development Goals as an example, the author presents an outline of the policy and regulatory frameworks essential to understanding the worldwide health environment (UN SDGs). It also outlines the responsibilities of patients, healthcare providers, payers, and researchers in implementing blockchain technology into the healthcare system. After identifying and synthesizing these barriers, the article describes a future in which the broad adoption of blockchain technology in health, made possible in part by the MIoT, can better serve public health on a worldwide scale.

Keywords: Blockchain technology in health care, supply chain, data management.

1. INTRODUCTION

Blockchain

Data in a blockchain network is stored on computers called nodes. It's an excellent method of keeping sensitive information on a network safe. Recent technological developments have made it possible to send private information over the internet without compromising its safety. The ability to access all relevant files in one place is a major benefit of this system. To further simplify the process of scanning a single patient database for trial participants who meet particular criteria, blockchain eliminates duplicate patient information. For those unfamiliar, blockchain is a distributed, shared ledger that is updated and maintained by a network of computers (known as "nodes") [1,2]. Each member of the network has access to the same database, making it easy to view the status of any given project at any given time. This technology has the ability to bring together previously separate systems, illuminating the benefits of individualized treatment in ways that were previously unimaginable. So, it is generally accepted that Blockchain is both secure and immutable. Blockchain relies on its three fundamental components: blocks, nodes, and miners. All the information that makes up a blockchain is not stored in one place. Instead, many Blockchain copies are made and scattered throughout a distributed system of computers. As a new block is added to the Blockchain, all of the copies of the Blockchain across the globe are automatically updated. The fundamental steps of Blockchain technology are depicted in Fig. 1. In order to facilitate peer-to-peer (P2P) value transfers, blockchain operates on top of the internet on a distributed network of computers that all execute the protocol and have an identical copy of the transaction ledger. You have your pick of public Blockchains, private Blockchains, hybrid Blockchains, and Blockchains governed by a consortium. There are a variety of Blockchain networks, each with its own set of advantages and disadvantages.

First implemented as a public ledger, Blockchain is credited with popularizing distributed ledger technology and inspiring the creation of digital currencies like Bitcoin (DLT). Less reliance on top-down management will do away with problems like data secrecy and lack of accountability. Rather than relying on a central server, the data in a DLT operates in a peer-to-peer network. Due to the decentralized nature of the system, a reliable data authentication technique is even more important.

Private Blockchains are those that are exclusively accessible within an authorized network or are under the control of a single administrator. Private blockchain networks are like public blockchain networks in that they enable P2P communication and decentralization, but on a much smaller scale. In a private Blockchain network, the creator is always aware of all nodes. Users' complete anonymity on the open web makes it impossible to design solutions based on user permissions.

Several businesses employ a hybrid Blockchain that combines aspects of both private and public Blockchains. Enterprises can control who sees what information on the Blockchain and whether or not it is made public by establishing a separate, permission-based system that operates in concert with the public, permission less system.

Need of Blockchain In Healthcare:

In healthcare, for example, speedy development is of the utmost importance. High-quality healthcare facilities that are also up-to-date on technology are a necessity in today's culture. Given this context, Blockchain technology could play a critical role in bringing about a revolutionary shift in the healthcare industry. The healthcare system is also shifting toward a patient-centered strategy, with an increased focus on two key elements: easy access to services and sufficient healthcare resources. As a result of blockchain's benefits, hospitals may be able to provide higher-quality care in more comfortable settings to their patients.

The same technology also easily fixes Health Information Exchange, a time-consuming and redundant process that contributes significantly to the high prices in the healthcare industry. Public participation in scientific research in the field of medicine is made possible by Blockchain technology. Treatment for various groups can benefit from more public health research and data sharing. In the past few years, we've been able to consolidate all of our healthcare data into a single repository [13-15].

Protecting, disseminating, and interoperating with patient data have been the biggest challenges in population health management. Professionals in the blockchain space have developed a trustworthy solution to this issue in the form of a distributed ledger system. This technology improves safety, communication, interoperability, data integrity, and access in real time when used properly. When it comes to keeping private information safe, companies working in healthcare and wearable technologies have their own set of issues. Blockchain technology is used to address these concerns [3] since users in the healthcare industry need a foolproof system for storing, transmitting, and consulting data across networks.
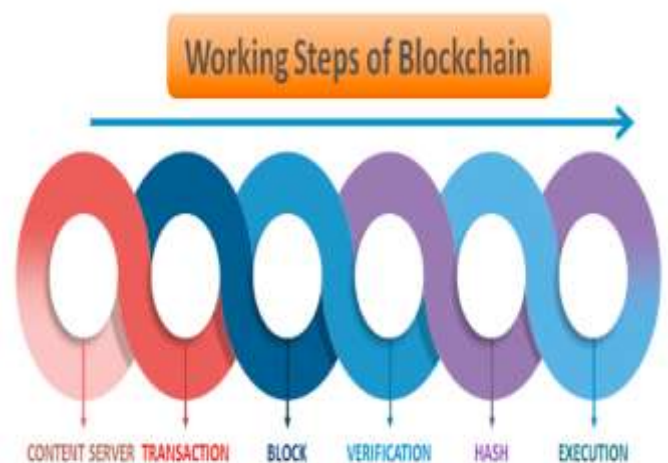

Fig1. Working steps of Blockchain Technology.

2. CLASSIFICATION OF BLOCKCHAIN

A blockchain might be public, private, or consortium depending on the permissions granted to its users. Precisely speaking, a "public chain" is a blockchain that anyone can join. Most people think that public chains are truly decentralized since the information they hold cannot be modified. Consortium chains are private, invitation-only networks built with appropriate permissions for read/write access and participation accounting. Only members of the private organization who have been given permission to do so are able to access the private blockchain, make transactions, and make changes to the ledgers stored there. Just a certain amount of nodes can take part. In Table 1, we see the key differences between the most popular blockchains.

Table 1. Comparison of different types of blockchains.

	Decentralization	Throughput	Cost	Scalability
Public chain	high	low	high	poor
Consortium chain	medium	medium	medium	great
Private chain	low	high	low	great
Hybrid chain	·	·	low	great

Consensus Algorithm

Due to the distributed nature of the peer-to-peer network, transactions may arrive at nodes out of sequence [4]. Every participant in the network must agree on the validity of monetary transactions for them to be valid, and this can only be accomplished through consensus procedures. Proof-of-work has been the first successful consensus mechanism for a distributed ledger (POW). A solution to the Byzantine problem called Practical Byzantine Fault Tolerance (PBFT) [5] has been proposed. The blockchain will continue to operate smoothly even if certain nodes have been hacked or are behaving maliciously, thanks to this feature.

Smart Contracts

Data-driven agreements may now be communicated, verified, and enforced with the use of "smart contracts" [6]. If a trusted third party is not immediately accessible to verify a transaction, smart contracts can still be put into operation, and they can even save a record of all previous deals. When the customer confirms the transaction by clicking "Complete," the software system fulfills the agreement. Without the requirement for a trusted third party to verify the legitimacy of a transaction, smart contracts deployed on the blockchain can guarantee the satisfaction of all parties. To clarify the inner workings of a smart contract, this diagram was created.

Decentralized:

Because to its computerized monitoring and arbitration, smart contracts can be enforced with almost little involvement from a human third party.

Untamperable:

As soon as a smart contract is put into action, its terms are binding on both parties. This Agreement, once signed, shall be final and binding in all respects;

Low cost:

As a third party arbitrator is not required once a breach of contract has occurred, smart contracts save both time and money compared to traditional contracts.

Open and transparent:

Once a contract has been deployed, its contents are accessible to anybody and will be executed in line with the code that was used to create it [7].
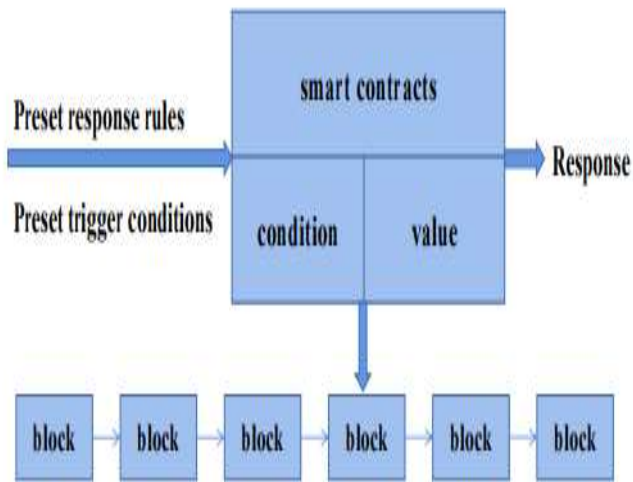
Fig. Smart contracts

3. BLOCKCHAIN HEALTHCARE USE CASES

Startups are implementing some uses of blockchain technology in healthcare, while larger businesses are testing out others in pilot programs to improve data security. Let's look into the applications of blockchain technology in the medical field.

Drug traceability

The "traceability" of a drug is defined as the ability to track it from the point of manufacture all the way to the point of administration. An immutable record of drug product transfers is possible with blockchain technology, which might significantly enhance the tracking of medications. Most current drug tracking systems rely on a central, vulnerable database that hackers can easily breach[8].

Using a blockchain-based system, it may be possible to build a distributed and immutable ledger of all transactions involving pharmaceutical items. Authorities can improve their counterfeit product detection and recall times. When combined with AI and IoT, blockchain also has the potential to be used to provide real-time tracking of pharmaceutical supply. This would enable for a more rapid and effective response in the case of a drug shortage or recall.

Walmart, IBM, Merck, and KPMG have collaborated to pilot a blockchain system for the better management of prescription drugs across the supply chain. The point of all this work was to make sure that people only got their hands on genuine drugs.

Electronic health records

One potential application of blockchain technology in healthcare is the creation of a centralized electronic health record system. They may help hospitals save lives by allowing them to provide better care at lower prices without sacrificing quality. Yet, there are drawbacks to using electronic health records. Safeguarding sensitive data can be a daunting task.

These days, most EHRs are kept in centralized, hackable databases. Potential privacy concerns for the affected patients may arise from this. The decentralised and trustworthy ledger system offered by blockchain technology could be the answer to this challenge when it comes to the long-term storage of medical records. By the use of blockchain technology, people may be able to decide who has access to their medical records. Organizations everywhere are hard at work developing enterprise health record (EHR) solutions that can store and verify data via blockchain.

Medicalchain, a blockchain healthcare firm based in the United Kingdom, has developed a reliable method of transmitting personal health data and medical records. To help people take charge of their health and make educated decisions, Patientory is creating an electronic health record solution based on the blockchain.

Blood plasma supply chain

The use of blockchain technology in healthcare has the potential to enhance plasma supply chains by allowing the sharing of accurate data amongst all parties involved. There are a lot of moving parts in the current plasma derivatives supply chain because of the number of hospitals and blood banks involved in these potentially lifesaving treatments.

Yet, plasma shortages can occur at the worst conceivable times for patients if the system is not optimized and human error is not avoided. Market research indicates that the value of the plasma supply chain market will increase to $15.5 billion by 2024, thanks to the industry's strong growth. There could be more deaths in the event that plasma is in short supply.

Blockchain, as a decentralized platform for all parties involved in plasma shipments, may be able to solve these problems by making it easier to share information and monitor their progress in real time. If blockchain technology can be refined, it might be used to ensure that people always have access to their life-saving drugs.

In Canada, blood products may now be traced in real time thanks to a collaborative effort by Canadian Blood Services (CBS) and EY Canada, which has also boosted openness throughout the system.

Prescription Drug Monitoring

Also, blockchain may be used in the medical field for tracking prescription drugs. Almost 18 million Americans (6.2% of the adult population) used prescription drugs last year. Since blockchain technology permits the secure and tamper-proof tracking of pharmaceuticals, it may be able to assist with this problem.

Each time a patient receives a dose of medication, a new entry is made in the distributed ledger that uses blockchain technology. When authorities are able to track the distribution of legal pharmaceuticals, they will be better equipped to identify instances of misuse and abuse. Blockchain technology might be used to authenticate the identity of both patients and healthcare providers, limiting access to restricted pharmaceuticals to only those who are legally entitled to hold them.

An emerging company in the field of healthcare IT, called BlockMedx, is developing a blockchain-based platform that will allow patients to keep their medications secure and accessible from anywhere. BlockMedx's technology might be used by pharmacies to verify prescriptions and track the dispersal of medications.

Medical staff credential verification

One of the most significant applications of blockchain technology in healthcare is the verification of medical professionals' credentials. Statista estimates that there are 1,073,616 medical professionals currently active in the United States. There are a lot of doctors and other medical professionals out there, and it can be difficult to verify their qualifications.

This is why more and more hospitals are using blockchain technology to verify the credentials of their employees. By offering a trustworthy and efficient means of verifying healthcare professionals' credentials, blockchain technology has the potential to radically alter the current system.

What's more, blockchain provides an immutable record of credentials that may be used to track the career trajectories of medical staff. For this reason, blockchain-based credential verification is gaining significance in the healthcare industry.

Breakthrough in genomics

The promise of genomic research to improve healthcare has been well recognized. By 2027, the global market for blockchain applications in genomics is expected to reach a value of $1,258.3 million, as reported by Emergen Research[9].

In genomics, one of the biggest problems is the difficulty of exchanging data. Patients are understandably wary of disclosing sensitive genomic information. Reliable and decentralized systems for transferring genetic data are being established using blockchain technology. As a result of this method, patients can grant researchers access to their genomic data without giving up full ownership of that data.

Nebula Genomics is a forerunner in the field since it employs blockchain technology to create a distributed network for the sharing of genomic information. It's helping build a genetic database for research in medicine and other fields. The firm aids in the gathering and distribution of patient genetic data in exchange for cash.

Moreover, EncrypGen is developing a blockchain-based repository for protecting genetic data. Using the EncrypGen service, patients may control who has access to their genomic data and even get rewarded for sharing it.

Supply chain management

International trade of pharmaceuticals, medical devices, and associated services is vital to the healthcare industry. Blockchain technologies have helped solve multiple issues with healthcare supply chain management. RFID and EPCIS are only two of the many technologies used to ensure the security of the pharmaceutical supply chain (electronic product code information service).

When this technology is used in the production of medicines, medical standards can be reliably met. Counterfeit drugs and medical equipment can have their origins tracked with the use of blockchain technology. A growing number of companies are developing blockchain-based strategies to address these issues in the healthcare industry.

An American company called Chronicled has developed a system that uses blockchain and the Internet of Things to track the distribution of essential medical supplies. Manufacturers, distributors, and pharmacies may track and manage who has access to medical supplies with the help of Chronicled's real-time supply chain visibility.

Iot Security For Remote Monitoring

Devices connected to the Internet of Things (IoT) are gaining prominence in the medical field as a means of remote patient monitoring. Internet of Things devices, such as wearable sensors, may monitor physiological parameters including heart rate, body temperature, and blood pressure. After that, the information is transmitted to a central repository from which healthcare providers can access and analyze it.

Sadly, however, many IoT devices lack adequate security measures, making them susceptible to hacking and data breaches. Access to sensitive patient data by hackers is a serious security concern for the healthcare industry. The secure data storage and transmission protocols offered by blockchain technology may prove useful in addressing this concern.

In the same way that blockchain technology helps create reliable IoT networks, it also helps people use them. For instance, IoT devices can use the IOTA platform with confidence. The IOTA platform uses blockchain technology to generate a permanent ledger of all transactional activity. Use this ledger to keep track of where your Internet of Things devices are and what data they're sending back.

Now that we've discussed some of the healthcare applications of blockchain technology, we can move on to the challenges that still need to be resolved before the two can genuinely go hand in hand.

4. WAYS BLOCKCHAIN IS TRANSFORMING THE HEALTHCARE INDUSTRY

There would be several advantages to using blockchain technology in the healthcare sector. We'll take a look at some of the technology's most intriguing potential uses in business, as well as some of its most notable advantages.

Improved Data Security

The adoption of blockchain technology has enabled the storage and management of medical records in a way that is immutable, transparent, and tamper-proof. Blockchain technology has the potential to address many problems within the healthcare industry, including security breaches, system incompatibilities, and fraudulent activities.

Blockchain technology is being used by the healthcare industry to store patient data on a distributed ledger rather than a centralized database. This makes it harder for hackers to gain access to and make changes to people's medical records. In addition, blockchain enables secure data sharing in the healthcare industry without compromising patient confidentiality.

Information stored in a blockchain cannot be accessed by anybody without the appropriate authorization. Eventually, healthcare fraud and corruption may be combatted with the immutable record of blockchain transactions.

24/7 Data Monitoring

There must be constant data monitoring in healthcare, especially for the sake of EHR administration and enhancement. Every day, many people's lives are at stake, and the consequences of an error can be catastrophic.

Everything related to a patient's health, from blood pressure readings to prescriptions, needs to be stored and easily retrievable. Despite the obvious advantages of better data accessibility, it is not always attainable due to restrictions in the current healthcare infrastructure (caused by things like data breaches, lack of interoperability, etc.).

Blockchain technology is useful in this regard. This decentralized system could make it easier to handle electronic health records, and it would make data available at all times. Further, by offering a consistent means of data sharing amongst healthcare organizations, blockchain can help with interoperability concerns.

Improved Clinical Trials

The worldwide market for clinical trials is anticipated to increase from a projected $38.7 billion in 2021 to $52.0 billion by 2026, a CAGR of 6.1%. Several factors, such as an increase in clinical trials and the need to outsource research and development and the marketing of pharmaceutical products, are driving the industry's expansion.

Clinical studies are extremely important, but they can take a long time and require a lot of individuals to participate. Clinical trials may have setbacks due to inefficiency and prolonged timelines. Another issue is that data silos make it hard to discuss the results of clinical investigations.

Clinical trial data management and storage might be simplified and made more trustworthy with the help of blockchain technology, which could help address these issues. Using blockchain technology into clinical trials could improve data tracking transparency and reduce the potential for human error. When adopting blockchain technology, researchers can more confidently verify the identity of both patients and clinicians participating in clinical trials.

Improved Drug Safety

The prevalence of adverse medication responses is a big challenge for the healthcare business. They cause a number of deaths and hospitalizations annually. It is estimated that the annual cost of dealing with drug adverse effects will likewise be in the billions.

Thanks to a blockchain-based database, the history of where medicines come from can be traced at any point in the shipping process. In this way, contaminated or counterfeit drugs could be quickly identified. Early reaction detection is also enhanced by blockchain technology's ability to record and verify results.

Blockchain, a form of distributed ledger technology, may have profound effects on the medical field. There are a number of approaches to this problem, one of which is ensuring the safety of medication delivery networks.

Smart Contracts

The healthcare system stands to benefit greatly from the implementation of blockchain technology's smart contracts. Automated appointment scheduling, insurance coverage verification, and claims processing are just some of the many uses for them.

There has been some consideration given to the use of smart contracts to control who gets access to patients' personal information and medical records.

Claims And Billing Management

Medical claims, including those for diagnostics, drugs, and other services, are submitted and processed by claims and billing management. Hackers gaining access to patients' medical records led to several instances of fraud and theft.

This problem can be easily remedied by using blockchain technology, which enables the recording and storage of medical data in the open digital ledger, where all parties can view when information is modified.

Blockchain technology has several potential applications in healthcare, and its use has already shown promising results, including lowering the prevalence of medical errors and improving population health.

To further understand the disruptive potential of blockchain in healthcare, we will now look at several concrete use examples in this area.

5. THE CHALLENGES OF BLOCKCHAIN FOR HEALTH CARE

Adopting this technology on a wide scale will be challenging and risky. These are some of the most major potential drawbacks:

Cryptocurrency

Blockchains are distributed ledgers that verify transactions in digital currencies like bitcoin. Because there are no actual coins, there is no shortage. Instead, the currencies exist only as lines of code that are stored in digital wallets that can be accessed only with a secret digital key. Bitcoin and Ether currently account for the vast majority of all cryptocurrency transactions. Both have the potential to gain or lose value by thousands of percent in a single year.

Several innovators, especially those in the healthcare industry, see the possibility of utilizing bitcoin to incentivize constructive behavior. For instance, if you exercised three times a week as your doctor prescribed, you might be rewarded with the hospital's branded cryptocurrency. There has been no implementation of this idea in hospitals, although it is neither impractical nor difficult to accomplish technically.

Outside of the medical field, "normal crypto stuff" presents regulatory challenges. The healthcare coins are "quite involved" even without that extra complication, as Bass puts it.

Web3 advocates speculate that if patients were compensated in bitcoin for their participation, they would be more likely to take better care of themselves, share their medical data, and engage in other beneficial behaviors. Yet, speculators would undoubtedly enter such a system, which might lead to the manipulation

of coin prices. As an added complication, the IRS and the SEC do not agree on how to handle the regulation of cryptocurrencies. The ability of enterprises to take advantage of such benefits may be severely constrained by forthcoming regulations.

NFTs

Identical in many respects to a cryptocurrency, a nonfungible token (NFT) is a digital asset that cannot be duplicated. For the most part, NFTs have been used as tokens for ownership of pieces of art, with investors able to achieve capital appreciation in the same way that one would with a conventional piece of art (albeit obviously not one that can be hung on a wall).

Yet, you may put the tokens to good use by adding your personal information, medical history, and other health-related details to a permanent database. This information may be freely shared. If you own the NFT storing your workout data, for instance, you may share relevant information with your physical therapist or even sell it to a research organization. Because collecting and storing NFTs requires some technical expertise, the current state of the user interface makes it challenging to onboard a significant number of individuals.

Security

It would be very difficult to try to hack a blockchain network. The Bitcoin blockchain has never been compromised, and Ethereum's was breached only once, soon after its inception. It is quite unlikely that an event of this scale will happen again soon. Despite their value, dApps built on blockchains to handle data, IP, ID, and other services are occasionally vulnerable to skilled hacking. Given enough time, it should be able to crack the cryptographic safeguards built into blockchains.

Until then, hackers can easily exploit anyone who fall for phishing schemes. A blockchain cannot be hacked, but an individual's private wallet passcode could be stolen. To give out those phrases would be like handing out the safe's combination. If this information falls into the wrong hands, the thief will be able to access everything in your digital wallet, including any cryptocurrencies or NFTs, as well as private

information like your medical records. By its very design, blockchain technology would make a permanent record of thefts. Yet since blockchains don't have any morals, the system wouldn't prevent it.

Distributed Autonomous Organizations (DAOs)

DAOs, or decentralized autonomous organizations, are essentially online communities that are funded by bitcoin and where most significant decisions are decided by voting. They do not have a central authority or leader. While DAOs have been around for almost a decade, their popularity has recently skyrocketed thanks to their lack of hierarchy among entrepreneurs of all shades. Innovating doctors are looking at DAOs for funding, and others are assisting people with rare diseases in forming groups to raise money for medication discovery. Because of the importance of making a profit, investors and entrepreneurs sometimes ignore promising cures for less common ailments. To this day, though, practically everyone is waiting until DAOs are more secure and easier to explain to stakeholders before jumping in. As of yet, DAOs have a less than ideal user interface. Comparable to the communes of the 1970s, but with more money and an emphasis on commerce. On online forums run by the Discord service, they talk to one another.

In Bass's opinion, the Discord servers are a complete mess. Suggesting that a doctor join Discord would be humorous.

Cross Chain Portability

The interoperability across blockchains necessary to significantly modify the US healthcare system is not yet in place, despite the existence of decentralized applications (dApps) that ease the transfer of data from one blockchain to another. One example is the sharing of patient records between hospitals in different chains. Right now, that's not always simple. A unified healthcare system is not possible unless this becomes more practical.

Credentialing

Credentialing is a major problem in the healthcare industry, but blockchain technology seems like a perfect solution. At least four or five healthcare

networks and insurance firms are in your doctor's network. The doctor's identification must be confirmed by each of these institutions. In its current analog form, this process might take months to complete and requires confirmation every two years. Due to the fact that no healthcare facility currently shares this data, it falls on each facility to collect it independently. As a logical application of the potential advantages blockchain technology may give, it is already being used by a number of companies. Yet, companies pay millions on "traditional" certification services each year.

A digital wallet is a safe place for a medical professional to store their NFTs. Yet, it's possible that today's doctors lack the technical know-how to pull that done. A doctor today "wouldn't know what to do with a self-sovereign wallet," Bass says.

The Environment

There is some worry about the amount of energy used by Bitcoin and Ethereum computers to validate and secure "blocks" of data on the chain, which are units of the chain's data that are transferred between users. It's a real issue at the moment. Yet, Bitcoin users are quickly shifting to renewable energy sources due to their reduced costs and longer lifespan. Additionally, Ethereum plans to implement a new blockchain technology this year called proof of stake, which will reduce its electricity consumption by more than 90%. Numerous governmental and private supply chains are currently utilizing this low-energy method of data validation.

The healthcare sector will be affected by blockchain technology. This innovation has the potential to bring in a new era of healthcare, one in which patients' private information is protected and all prices are transparent. A region where donating and receiving organs poses no significant financial burden. While not inconceivable, there are still some technological obstacles to overcome before any of this can become a reality.

6. BLOCKCHAIN APPLICATIONS IN THE HEALTH SECTOR

Blockchain's potential uses in healthcare are still being explored, but coverage has increased recently. Academics rarely release a blockchain system prototype, pilot installation, or component list (Figure). Healthcare blockchain use is barely beginning. Due of its benefits, Estonia and Malta have adopted blockchain technology. Improved data security, better patient consent management, and more. We'll look at blockchain's potential in patient identity and verification, dynamic consent, and pharmaceutical and medical supply chain management.
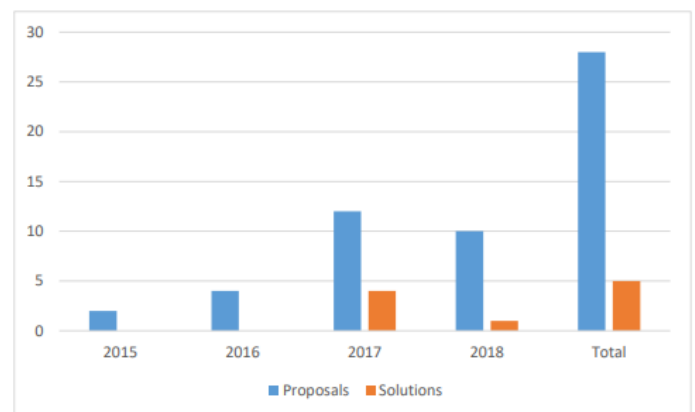

Figure. Most research papers on blockchain in health care describe proposals, not solutions

BLOCKCHAIN FOR IDENTITY MANAGEMENT IN HEALTH CARE

Correctly identifying patients, caregivers, and institutions is essential for good health (such as hospitals, pharmacies, universities, and other research institutes). Blockchain technology can improve identification by increasing integrity, transparency, and reducing identity versioning. As wearable medical gadgets and the Internet create more data, matching it with patients' electronic medical records will become more important.

Health care providers—individuals and organizations—must offer accurate and up-to-date location and service availability information for patients to find them, accrediting bodies to recognize them, and payers to compensate them. Blockchains may improve data reliability and veracity.

The blockchain can track file views and changes. KSI's blockchain application protects Estonia's electronic

health records and other government data from hackers. KSI protects data without compromising privacy (e-Estonia, 2020). Electronic records show if a file was edited. An unauthorized access request can be investigated immediately to prevent system damage. The blockchain doesn't quickly intervene like high-crime cameras. The tape's immutability and public accessibility discourage.

Real health records and metadata are off-chain, but just a small portion of the transactional footprint (Vazirani, 2019). This shows that blockchain in a health information system, like other technologies, works best when coupled.

BLOCKCHAIN FOR MANAGEMENT OF PATIENT CONSENT AND DATA ACCESS PERMISSIONS

Customers can transparently and auditably access their medical records utilizing blockchain technology and their own credentials and encryption key. Health practitioners, service providers, and other relevant actors may release patients' medical records and other information for health care, research, statistical analysis, or other secondary uses (such as researchers and social care providers). Blockchain's "dynamic" permission is a welcome alternative to "blanket or one-time-only" consent models in a future where electronic data can be accessed and reused eternally and where new research topics and data use incentives develop periodically. Changes may require a new agreement or authorization section.

The Malta Biobank is using the Dwarna blockchain to dynamically manage bio specimen authorization for scientific research (Mamo N, 2019). Dwarna's blockchain records user approval. If individuals may choose the study, rescind their agreement, and request that their bio sample be destroyed, people are more inclined to trust the biobank.

Research Foundry, a blockchain program, manages rights and access to health research resources, such as COVID-19 pandemic research (Burstiq, 2020). The idea is to simplify data sharing between countries while safeguarding privacy. This method lets network nodes choose which data to share. The blockchain's

nodes wouldn't see a health data repository's contents, but its metadata would be public. Repository owners might opt to share all or part of their repository. The technology supplier cannot access the data repository without consent from the owner.

BLOCKCHAIN FOR MANAGING MEDICAL AND PHARMACEUTICAL SUPPLY CHAINS

Supply chain administration uses blockchain technology most. Pharmaceutical, clinical supplies, blood, and medical device supply chains use blockchain technology. Here are some blockchain applications: Clauson (2018).

Product identification: Serial numbers simplify product verification (e.g. In case of product failure).

Tracing: Distributed ledgers verify information for manufacturers, shippers, and merchants.

Product verification: Public and private sectors can identify dangerous or phony items and verify product authenticity.

Notification and response:

Help the public safely report illicit items or services to authorities. Product or licensing details. The drug supply chain is untrustworthy. Stopping drug trafficking, counterfeiting, and protecting intellectual property are examples (Mettler, 2016). Blockchain data's immutability makes it appealing for verifying parties' identities (MediLedger, 2020). Hyperledger's Counterfeit Pharmaceuticals Initiative detects and prevents counterfeit pharmaceuticals using time stamping and blockchain storage (Taylor, 2016). Blockchain's transparency and immutability could help stabilize pharmaceutical supplies. Chinese hospitals are using blockchain technology to ensure Covid-19 trial patients receive their prescriptions on time (Ting DSW, 2020).

POLICY CONSIDERATIONS FOR DEPLOYING BLOCKCHAIN

As shown by theoretical and practical examples, blockchain can improve health system digital transformation in identity verification, patient consent, data sharing and access permissions, and medical and pharmaceutical supply chain management. The policy's goals can only be fulfilled if complementing

technologies and an all-encompassing health information system and data infrastructure are introduced at the same time.

Blockchain technology's potential to transform healthcare is exciting yet uncertain. Blockchain technology cannot solve the health industry's biggest problems—data interoperability and data governance.

Blockchain technology eliminates the need for a centralized database but not a government. Due to patient privacy, blockchain-based healthcare applications will need laws, regulation, and sector-specific norms and protocols. The consensus mechanism, which is not technological, manages blockchains by relying on network participants' agreement.

Many decision-makers consider the cost of developing cutting-edge tech. Estonia's blockchain-enabled healthcare system shows that initial expenses are low. New functionality is cheaper and easier after the skeleton is established. Changing processes, workflows, and attitudes to maximize new technologies drives technological transition costs. Data kept "on chain" and blockchain efficiency will effect network upkeep costs.

Blockchain technology's radical change in data management and storage requires stakeholder participation. These tools require training for healthcare professionals. Public consultation and information to educate patients on how to utilize the technology and their rights and obligations are essential to ensure a smooth rollout when this technology empowers patients with more data control and access.

Healthcare administrators can employ blockchain technology as follows.

Fit-for-purpose. Blockchain, a distributed ledger technology, has uses beyond financial transactions. It must be compared to other tactics to determine its efficacy.

Governance and regulatory alignment. Due to its unique properties, blockchain-based systems must comply with applicable laws, regulations, and data governance standards.

Incremental integration. Blockchain-enabled solutions must be assessed inside the current system. To optimize existing infrastructure, blockchain technology should be piloted on a small scale.

Education, awareness and user-based design. Blockchain technology requires a paradigm shift in data and information use. More education on this technology and data ownership, access, and privacy options would benefit patients and the wider public.

7. CONCLUSION

Blockchain shows considerable potential for use in the healthcare industry due to its encryption and decentralized features. It helps prevent the spread of fake medications, improves communication between hospitals, and makes EMRs more secure for patients. Digital agreements made possible by intelligent contracts are revolutionizing the healthcare industry, making it one of the most promising applications of Blockchain technology. With the use of intelligent contracts, businesses will be able to save money by doing away with middlemen during the entire payment transaction process. Blockchain will not be able to realize its full potential in the healthcare sector until other cutting-edge technologies are broadly implemented. This includes clinical studies, healthcare insurance, tracking prescriptions, and other tracking systems. Following medical equipment through its lifespan on a distributed ledger like Blockchain allows hospitals to keep track of patient care and outcomes. Faster clinical interventions with enhanced data retention are both possible thanks to the usage of blockchain technology to better handle patients' medical information, including tracking and the insurance mediation process. In the long run, this innovation has the potential to drastically transform the relationships between patients and healthcare providers.

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