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Blockchain technology in the health sector

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***Abstract*---**Rapid development and technological advancement have brought a lot of changes in the health industry. It makes use of a variety of technologies, including the Internet of Things" IoT and "Blockchain". These innovations are being used in a variety of applications connected to daily healthcare activities. According to the Global Blockchain Study, numerous firms in several areas, including medical, are extending, their Blockchain activities. Even though "blockchain technology" has attracted a lot of attention in the last decade, there are still many barriers to its incorporation with IoT systems[17] and use in the medical industry. Blockchain technology is used to secure healthcare-related information securely to increase cybersecurity in the healthcare sector. A mixed-method (Primary Qualitative and Secondary Quantitative) is used to collect relevant data related to Blockchain technology in Health care.

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Introduction

In the past few years, blockchain technology has acquired a lot of traction in a variety of disciplines, one of which is healthcare. This appeal stems from its distinguishing features: the lack of centralised control, a high level of confidentiality, and consent diffused over decentralised networks. As a result, in this paper, researchers give a modern evaluation of blockchain technology in eHealth in sequence to get a broad understanding of the issue and identify potential scientific fields and craze for this technology [1]. Many scientific breakthroughs have revolutionised the way people communicate, trade, and make decisions in the 21st century. Blockchain is a technology that is being hailed as among the most important technologies since the internet's inception. It is also known as the "second generation of the IoT technology." The growth of Cryptocurrencies such as bitcoin has undoubtedly helped blockchain gain traction throughout the world. Researchers, on the other hand, feel that blockchain is more than just cryptocurrencies and that it may provide bigger benefits to complicated network administrators. For digital payment systems and bank transactions, blockchain technology is widely employed. It's also employed in the automotive industry, cybersecurity, poll results, academics, healthcare, and temporal trend predictions [2]. Blockchain technology has recently garnered traction in a variety of fields, along with health care as it provides a more secure and decentralised network that can function without the need for a central authority.

Fig 1. “Blockchain technology in healthcare” (Source: [2])

The blockchain network's distinctive selling proposal is that once electronic confirmation occurs, the network itself speeds and authenticates the subsequent transaction process. It protects the history of transactions and allows data to be exchanged immediately between other entities. This article is a detailed discussion of how blockchain technology works and how it might be used in

difficult scenarios like public health programs. The administration of client EMRs is the key benefit of blockchain technology in medical institutions. Patient records are now securely maintained in a variety of locations, scattered across a variety of institutions, clinics, and insurance firms, with no complete access to a common patient's record. Patients might make organized information available to experts by storing health information in the blockchain [3]. All of these elements can reduce storing expenses and enhance performance, maybe even including the use of smart agreements (automated executing contracts with conditions of the agreement between the parties specifically written on code lines) created as a layer on the blockchain.

Literature Review

In current hospital ecosystems in developed countries, blockchain is among the most widely employed innovations in medical records (EMR). Blockchain technology is suited for recording, maintaining, and exchanging personal healthcare information in EMR because of many aspects such as decentralisation, data origin, and resilience. For instance, a health chain is a blockchain-based EMR solution that relies on IBM's hyper ledger fabric. This technology aids in achieving expandable cybersecurity and improving EMR functionality. Blockchain is thought to enhance payment activities, reimbursements, and monitoring methods such as healthcare-associated infection surveillance. In healthcare organisations, blockchain can help with logistics and human resources management [4]. External vendors, for example, might supply medical systems with fake pharmaceuticals and substandard devices.

The use of blockchain can confirm safety requirements at various supply chain control components and alert authorities to potential anomalies. Furthermore, in the digital era, the human resource department necessitates the storage and use of employee details for presence, absences, disciplinary actions, and protective measures including complicated authentication processes. The use of blockchain technology can help improve the efficiency of these operations and help establish better healthcare organisations. Blockchain is currently being utilized to exchange healthcare information with patients and families because of its decentralised capabilities that prevent data security issues. Patient empowerment projects encourage the effective use of healthcare information systems to enhance patient-provider contact through internet technology [5]. Moreover, using biosensors, blockchain-based mHealth treatments enable access to medical information, overcoming access barriers in patient-level health care.

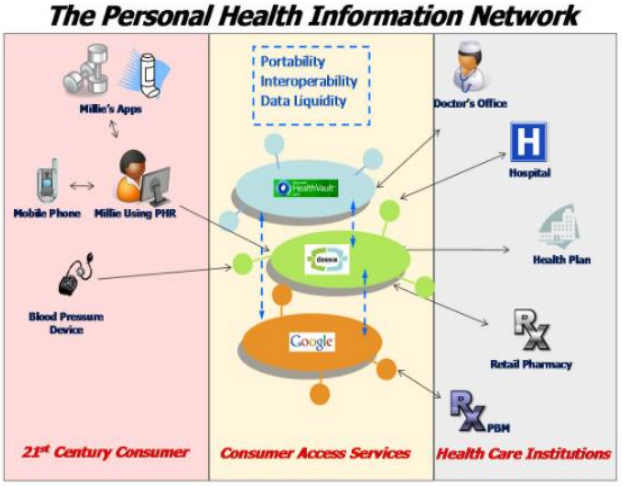

Fig 2. Personal health information architecture
(Source: [5])

Blockchain plays a significant role in the healthcare system in a variety of ways, as well as health is a significant component on which to focus. However, difficulties such as incorrect treatment based on “patients' protected data”, "drug counterfeiting," and "drug supply chain" are causing concern in several subfields of wellness.

The integration of health care providers and patients into the same blockchain network is known as “***Personal Health Information Architecture or PHI***”.

For patient health records to be accessible across a decentralized system, a framework for revealing private health information that improves security and privacy issues while also facilitating diagnosis in the e-health system [6]. The use of blockchain in healthcare can help to eliminate illegal pharmaceuticals, retain patients' electronic medical information, and assess drug integrity from the source to the final product. The “Geocoin blockchain” allows for the surveillance of drug data flow as well as the development of visibility statistics on drug transactions [7]. The “Gcoin blockchain's” advantages include the removal of fraudulent pharmaceuticals and the safety of people.

Blockchain applications in the healthcare sector

- ***Remote patient monitoring***

Fig 3. Remote patient monitoring system
(Source: [8])

"***Telecare medical information systems***" can use a blockchain-based "privacy-preserving location sharing mechanism". Decentralization, confidentiality, unforgeability, and layered privacy protection are all provided by the system, however, it ignores "scalability as well as interoperability concerns". To manage a "remote monitoring system", a decentralized patient software agent is used. Their method considers "three levels of devices": a body area sensor network, fog, and a cloud level where a Blockchain network is integrated [8]. The compatibility issue was not addressed, even though the system offers a dependable, secure, and private connection. They also shared some ideas on how to leverage Blockchain and decentralized "artificial intelligence" (AI) to safeguard the exchange of huge data to improve patient outcomes. Machine learning techniques can be used by decentralized AI for monitoring and treatment to ensure early disease detection. A technology based on the "Hyperledger fabric Blockchain" and "smart contracts" is also being developed to track patient vital signs [9]. Healthcare devices are also used in the network, which may be managed electronically by doctors.

- ***"Drug traceability"***

Many proposals have been made to link Blockchain with medicine supply chains for accountability and real-time monitoring of medicinal supplies during travel. In the "pharmaceutical sector", "***Ethereum Blockchain"*** is used to preserve data and create it publicly visible while maintaining preservation [10]. They proposed using thermal sensing devices to provide temperature readings during the transit of pharmaceutical supplies as part of their proposal. Besides, another Blockchain-based system is developed for drug traceability.

- ***"Tracking infectious disease during COVID-19 pandemic"***

Several technological businesses around the world have employed blockchain to construct applications and services to aid in the fight against the COVID-19 epidemic. To safeguard the access of information connected to COVID-19, blockchain has been implemented into a variety of technologies. In this context, "MiPasa" is a "World Health Organization platform" built on "Hyperledger Fabric" that supports the collecting of Covid-19 data. It allows scientists, technicians, governments, and health officials to share data more easily. This would aid in the

development of measures to aid pandemic control and contain the outbreak [11]. Civitas, a blockchain-based device is another development for detecting diseases during Covid 19. It uses “Blockchain technology” to establish a digital trail of COVID-19 diagnostic findings and “communication tracking” that can be verified. It also includes telemedicine technology that lets patients communicate with “healthcare professionals” to assess COVID-19 complaints, as well as doctors to monitor their patients' progress.

Security Implications of Blockchain in Health Care

Private permissioned blockchain implementation is said to provide high advantages for healthcare systems, but it also poses security problems. A central authority maintains the permissions to read and write activities on a private blockchain system, which are restricted to trustworthy and specified users. This technology gives you better control over your patient information by ensuring that only authorized users may view or update it. This has a favourable impact on the data's secrecy and sincerity [12]. Immutability also allows for the surveillance of patient-generated information for medical science, insurance claim activities for fraud detection and medicinal distribution networks for quality control. The presence of data integrity and progress tracking can also be enabled by a private blockchain network.

Smart contracts encourage patients to offer authorization and permission for scientists to view their health information while using patient-generated health information for the study. The patient data entry point, which is the patient's instrument, can be utilized to mimic the patient, jeopardizing data security. Discussing healthcare information with researchers puts the patient's privacy at risk; even if the information is pseudonymized, reidentification is possible [13]. However, efforts to improve patients' rights in blockchain ecosystems and build blockchain components for security are still in the early stages of development, and there is no assurance that privacy will be preserved.

Methodology

This research article has considered a primary quantitative or survey method for gathering statistical related data. In this context, 86 healthcare professionals have been selected to get their responses. Among them, 73 people have responded to the survey. Therefore, the population size is 86 and the sample size is 73. Moreover, excel graphs and charts are used for analysing the responses from surveys. Not only primary quantitative, but also a secondary qualitative method is also considered for this research paper to develop a proper understanding of the role of Blockchain technology in healthcare. Thus, it can be stated that mixed-method (primary quantitative as well as secondary qualitative) has been considered for this research paper.

Research questions:
What are the benefits of “Blockchain technology” in improving healthcare services in this present decade?
What are the challenges faced by the healthcare sector due to poor security in the healthcare industry?

Analysis and Interpretation

Closed-ended survey questions have been asked to healthcare professionals to get their responses.

Survey questions

Q1. Do you think that Blockchain technology helps to implement several advanced patient monitoring systems for improving patient care?

TABLE I. BLOCKCHAIN TECHNOLOGY HELPS TO IMPLEMENT SEVERAL ADVANCED PATIENT MONITORING SYSTEMS (SOURCE: CREATED BY THE RESEARCHERS)

Options provided	Total respondents	Collected responses	Percentile
Highly Agree	73	24	33%
Agree	73	20	27%
Neutral	73	4	5%
Disagree	73	15	21%
Highly Disagree	73	10	14%

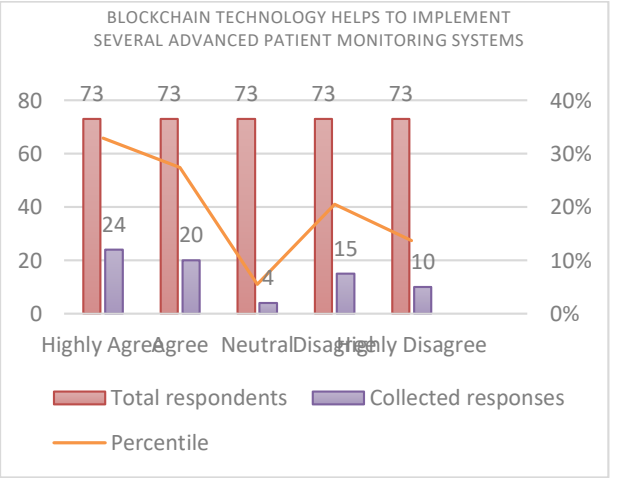

Fig 4: Blockchain technology helps to implement several advanced patient monitoring systems
(Source: Created by The Researchers)

Q2. Do you believe that Blockchain technology can improve system security in the healthcare system?

TABLE II. BLOCKCHAIN TECHNOLOGY CAN IMPROVE SYSTEM SECURITY IN THE HEALTHCARE SYSTEM
(SOURCE: CREATED BY THE RESEARCHERS)

Options provided	Total respondents	Collected responses	Percentile
Highly Agree	73	25	34%
Agree	73	20	27%
Neutral	73	4	5%
Disagree	73	13	18%
Highly Disagree	73	11	15%

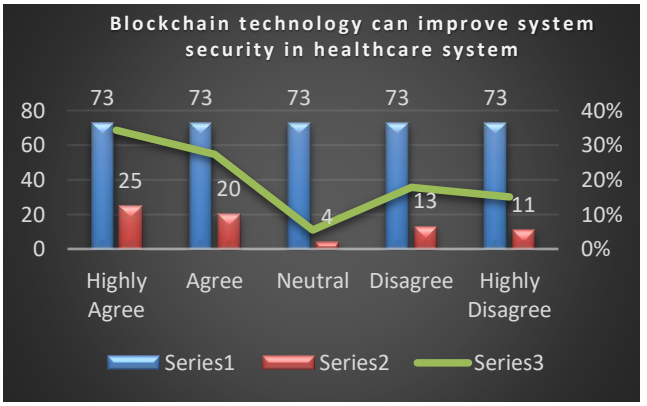

Fig 5. Blockchain technology can improve system security in the healthcare system
(Source: Created by The Researchers)

Discussion and Findings

"Need for Blockchain in healthcare"

Healthcare has become one of the industries where blockchain is thought to have great potential. To change healthcare, the priority has to be on information management, which can integrate diverse systems and improve EHR accuracy [14]. Blockchain technology can help with password authentication, the maintenance of a wellbeing audit trail along with information sharing.

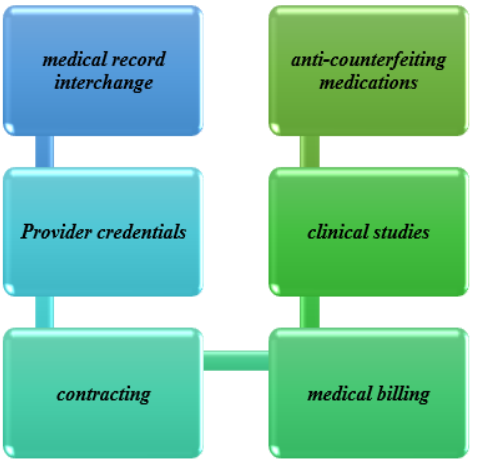

Fig 6. Different sectors where Blockchain is used
(Source: Created by The Researchers)

"Provider credentials", "***medical record interchange"***, "***contracting"***, "***medical billing"***, "***clinical studies"***, and "***anti-counterfeiting medications"*** are some of the other sectors where blockchain technology is used. Healthcare is changing to accommodate a more patient-centred approach [15]. Blockchain-based healthcare systems could enhance the safety and trustworthiness of client records by giving people control over their health information. Furthermore, it is vital in medicine to maintain track of individuals' health information. These are highly sensitive data, making them a prime target for hackers. It is also critical to keep all sensitive information safe. Another consideration is data management, which should ideally be handled by the patient [16].

As a result, another use case that can profit from improved innovative techniques is exchanging and obtaining management of patient health data. Blockchain technology is very resistant to damage and failures, and it offers a variety of access control options. As a result, blockchain is an excellent framework for healthcare data.

Conclusion

The goal of this study was to give an overview of the state of the art in blockchain study in healthcare and to highlight the research areas and innovations in this sector. Blockchain has the potential to enable the effective sharing of information between relevant parties while also protecting the patient's confidentiality and ensuring the data's security. Approval, legislation, and morality are all issues that need to be addressed before blockchain technology can be used. Taiwan is an outstanding illustration of how this new blockchain innovation may be used. In Estonia, blockchain is used to run the whole public health infrastructure. Other nations that have deployed real-time monitoring systems in several of their sectors include the United Kingdom, the United States, and Canada. It has been adopted at the national scale in England's Emergency Room Syndromic Monitoring System. At the provincial scale, Canada has established Emergency

Room Syndromic Surveillance. The European Antimicrobial Resistance Surveillance System is another amazing example of this use. As a result, we may deduce that blockchain technologies can maintain the key features of a perfect surveillance system. In terms of availability, reliability, consistency, selected confidentiality, distinctiveness, and timeliness, it may be more efficient and timelier than classical monitoring and control. Blockchain technology has a wide range of prospects in overcrowded and low-income developing nations like India, Pakistan, and Africa (in which medical systems are susceptible to epidemics and pandemics) by enhancing nations' ability with simplified warning surveillance for diseases with outbreak prospects, lowering mortality, mortalities, and financial cost. It is past time to apply blockchain technology to existing monitoring real-time healthcare system improvements in poor nations.

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