Block chain for secure privacy-preserving cancer data management

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Abstract

A new era in healthcare has been brought about by the rapid advancement of technology. This era is characterized by the search for safe and private solutions for handling sensitive health data, especially regarding cancer. The flaws in conventional centralized databases may be fixed by blockchain, a decentralized and transparent ledger system. Immutability, decentralization, and openness are its guiding principles, and they serve as the cornerstone of a safe and patient-centered handling of cancer data. The study explores how blockchain might be used in the healthcare industry for a number of purposes, from facilitating cooperative research projects to securely storing medical records. Some of the major uses are the development of tamper-proof medical records, the optimization of clinical trial administration, the promotion of data sharing interoperability, the protection of the pharmaceutical supply chain, and patient empowerment via consent management. Pilot programmers and real-world case studies support the potential of blockchain technology in healthcare by offering concrete proof of its effectiveness in safe cancer data management. The article ends with a future-focused section that highlights the continuous developments in blockchain technology and the teamwork required to successfully negotiate the challenges of incorporating blockchain into the healthcare system. By thoroughly analyzing the uses, difficulties, and suggestions for utilizing blockchain in the safe and private storage of cancer data, this study adds to the growing conversation about the nexus between blockchain technology and healthcare. The shared insights are intended to stimulate additional investigation, creative thinking, and cooperative endeavors to fully realize blockchain technology's potential to transform healthcare data management.

Keywords:

Blockchain (BC), Privacy-Preserving Cancer (PPC), Data Management (DM).

Introduction

The word "Block chain" can be explained in these words "a form of distributed database which maintains increasing and growing lists of different types of records, these records are called blocks". This technology has been used tremendously for privacy of data for cancer treatment and management. Now in these days, as the number of diagnosis and treatment for cancer is increasing day by day, the amount of data collected from patients at hospital is also increasing at faster rate. Physicians have to collect information from patients, including their family history and others. This type of information is necessary for effective and managed care for treatment of cancer. But nowadays risk of data loss has been unceasing and increasing, which had made this issue concerned[1].

Most of the information is shared by fax or mail, but due to less security, this method of transmission of data is not preferred in these days.

Then, there was a need to develop such a system that could facilitate effective and secure sharing of data from patients to physicians and vice versa. This data management also has the benefit that in this way, a single patient can keep his record for a lifetime and can also access multiple hospitals with the help of this data management. The study also looks at how blockchain may be used to secure genetic data, enhance the way billing and claims are processed, create a cancer patient continuum of care, and promote research collaboration with the possibility of data monetization. In addition, strategies for addressing obstacles including interoperability, scalability, and regulatory compliance are covered.

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How to cite this article: Shoaib M T. Block chain for secure privacy preserving cancer data management. J Carcinog 2023;22(1):71-78

The guidelines place a strong emphasis on the value of cooperative stakeholder participation, dealing with regulatory issues, making scaling plans, and giving user-friendly interfaces priority. This technology was named as Blockchain technology, which has ensured secure and private transmission and sharing of data[2, 3].

This technology is based on a web interface that is most probably used by patients and doctors. In this technology, a hybrid is used where Metadata will be stored in the form of a chain but the actual kind of data will be encrypted and stored in other cloud based storage of hospitals [4, 5]. This system also uses digital type of signatures for the secure use of this technology as well[6, 7]. This technology was started in Stony Brook University Hospital, including radiation for cancer treatment. The Blockchain framework that was used was named hyper ledger Fabric, which was open-sourced. In this Blockchain technology, encrypted blocks are utilized to verify and store data; it uses a P2P kind of network and consensus mechanism, which is utilized for data verification and trust establishment among different partners for information sharing[8]. This Blockchain technology is also known as distributed ledger technology, in which full data is structured in the form of blocks. Then these blocks may contain a single transaction or a bundle of transactions. The main part of Blockchain technology is privacy preserving Blockchain, which is mainly a subset focusing on improving participants' trust for secure data management and transaction. This technology has to meet the core principles of transparency and security[9, 10]. This Blockchain technology can also help to verify different types of data gained from patients for effective treatment and record. This Blockchain technology also reduces the cost for compliance and also helps in effective and faster data transmission for better health care and management. There are many benefits of Blockchain technology such as it is secure for transferring data, it is also transparent way of transmission of data, and it is the most efficient way of data transfer without any insecurity[11]. Blockchain technology has also benefit that it cannot be altered; this Blockchain data cannot be reversed, which shows that participants can trust on it for data transmission. This technology does not need intermediate parties to transfer and store data. This technology does not need any high consumption of energy. It does not involve any uncertainties related to regulatory. The traceability of data is also possible because of this Blockchain technology. As the use of social media is increasing day by day, the trust of people in sharing data by means of social media is decreasing at same type. People feel reluctant to share data even with physicians because of widespread insecurity of data loss or data misuse[12]. But this problem of data transferring has been solved by use of Blockchain technology because it is secure and reliable. The sharing of data is very necessary for medical science for the treatment of different diseases, especially cancer; the history of the patient, the financial condition, the heredity relationship, lifestyle, environment, and many other factors are to be known by physicians for better and effective treatment which has been made possible by the use of Blockchain technology[13]. Access to this Blockchain technology has also made it possible to share the same information with multiple hospitals because the records of patients are saved and secured; this is also the main benefit of Blockchain technology. But along with it, there are some challenges for Blockchain technology. For example, Blockchain technology demands high cost for its implementation, which is the main hurdle in the adoption of Blockchain technology. This is main reason which delays the implementation of this useful technology for transformation of data. The second problem related to adoption of Blockchain technology in health care aspect is that there is lack of government involvement in the adoption of the Blockchain technology in Healthcare centers. The third problem related to adoption of Blockchain technology is that it is lacking in incentive which is mandatory for adoption of Blockchain technology in diagnosis and treatment of cancer[14]. The next contributing factor to less adoption of Blockchain technology is the lack of skills which are necessary for implementation and maintenance of Blockchain technology in Healthcare centers. But in the long run, if these challenges are coped in an effective way, Blockchain technology will be a reliable method for data sharing and data storage for the diagnosis and treatment of different diseases such as cancer. Although it is effective step of technology towards use of technology in Healthcare aspect of humanity as well. The trust of patients can be truly gained by the effective implementation of this technology in the health sector, which can, in return, develop better relations of trust between patient and physician[15, 16].

Research objective

The main objective of this study is to understand the use of Blockchain technology for secure and effective transmission of data in Healthcare participants and patients, which can be effectively used by healthcare experts for effective diagnosis and treatment of different diseases such as cancer. There are some hurdles in implementation of Blockchain technology that must be addressed with proper heed [17].

The research represents that blockchain technology related to the secure and effective data management about cancer. This research is divided into five sections. The first portion represents the introduction it also describes the objective of the research. The second section represent the literature review, the third section presents the research methods, and the fourth part presents the result and applications. The last portion represents and summarizes the overall research study

and also presents some recommendations about topics.

Literature Review

Blockchain for Secure and Privacy-Preserving Cancer Data Management

A blockchain is a distributed, decentralized, and public network that helps in the storage of data at various places in order to record transactions. It helps in recording the data, which cannot be altered at any stage of the storage. As the data has been located in various nodes, it is easy to fetch for usage and difficult to alter [18].A block chain is created as a distributed database that generates a series of the lists of ordered record that are called the blocks. The cryptography is used to link such blocks or records. There is flow of the record in which each block contains the hash of previous blocks, transaction date and timestamp of the previous blocks[19].It was originally invented by the Satoshi Nakamoto in 2008 that served as the ledger for the bitcoin in cryptocurrency. It helped in overcoming the problem of double payment or spending that does not need any central server. Initially, the block chains referred to the recording and storage of the transaction. Later, they were tested for the usage in other fields of the life[20].The blockchain is the undercover technology for the bitcoin using the cryptocurrency. It is the peer-to-peer network for recording the transactions in Bitcoin known as miners[21]. With the increasing needs of the blockchains, there is a need to develop new solutions in the existing modules in spite of developing the blockchain from the scratch.

The architects of the blockchains develop the methods of introducing the technologies that will interrelate the industrial needs and software architects[22]. There is a need to have strong financial integration between the departments and people to implement the blockchain technologies. But the presence of weak integration leads to problems that disturbs the overall system[23]. With the increasing need to develop sophisticated healthcare facilities for treating the increasing number of patients. It is essential to make decisions based on the patient's history that is developed properly in a sophisticated manner. The electronic health records (EHR) are sensitive and can be invaded, it is important to secure the system by developing the proper chain of the work. In this digital era, there is are Internet of Things (IOT), which has several design issues for security and privacy. The security of the patient's data and health problems must be ensured with proper software. The blockchains help overcome the Internet of Things (IoT) problems. The development of the Ant Colony Optimization with Multi Kernel Support Vector Machine (ACOMKSVM) with the inculcation in the blockchain technology helps in developing the breast cancer Wisconsin dataset (BCWD) and the Heart Disease Data Set (HDD). The developing nations have been facing the severe challenges in the health facilities due to the lack of institutional and personal medications in the health care systems. In the past few decades, the health sector has developed a system of developing and securing the patient's data, creating a proper data set of the patient's disease. The Internet of Things (IoT) and Smart devices helps in monitoring the data from the remote areas in order to provide the people with proper treatments. In blockchain technologies, a new term if off chain, has been developed that computes the data and that is structurally external to the main blockchain technology. Off Chain Blockchain System (OCBS) works through the distributed network and interacts with the blockchain technology information's. They are the critical governance methods that are designed to provide the solutions of the off-chain and blockchain methods. There is a rapid development in the Internet of Medical Things (IoMT) that enables smart devices to create, generate, and transmit the data of electronic medical records. There is a continuous threat for the invasion of private medical information that can be maliciously used. Developing the Triple Subject purpose-based access control (TS-PBAC), which is easily integrated with the block chain transaction network.

The main purpose of the blockchain is to share the information and act as the intermediary to store the data and move it securely. It helps store the data in the decentralized form and easily fetches the medical data from anywhere. Healthcare clinicians use the blockchains to manage the clinical data trials, and maintaining the medical records electronically[24]. Data driven machine learning and deep learning help the clinicians to make wise decisions about the patient's health conditions. But, in some instances, it suffers from poor implementation due to unrealistic and fresh medical data in the system. A framework known as the health fed has been used to enable the blockchain and other health facilities to develop the structure that resolves privacy issues. The prevailing uncertainties in today's world raise the question for privacy invasion in the health sector as well. The use of blockchain has been widely observed in the healthcare sector. The computation of the data set in the clock chain widely decreases the healthcare cost for the computational purposes. Although blockchain has many benefits, it's important to consider drawbacks, including scalability, regulatory compliance, and compatibility with current healthcare systems. To successfully integrate blockchain for cancer data management into the healthcare ecosystem, stakeholders must work together and develop a well-thought-out plan. The blockchain provides the solutions for developing network that cannot be invaded. The Medical and Health sector is sensitive to an invasion like other industrial sectors' information. Privacy plays a pivotal role in the development of such blockchains[25]. Artificial Intelligence (AI) in healthcare department is useful in the

presence of the data quality and the forecasted results they generate. Distributed Machine Learning (C-DistriM) is feasible for inculcating the Artificial Intelligence in blockchain technology. It combines sequential distributed learning with blockchain methods to improve the medical history[26]. The key to successfully treating the patients is through timely diagnosis of the diseases. The sharing of information in time among the clinicians ensuring the privacy of the data, will help in taking the prompt decision about cancer patients. In the setting of decentralized blockchains, grave diseases such as cancer, the timely exchange of data among doctors helps in diagnosis and treatment in time.

Blockchain technology may, in fact, be quite important for guaranteeing the safe and private handling of cancer data.

1. Immutability: Data on the blockchain cannot be changed once it has been recorded there. By doing this, the accuracy of data pertaining to cancer is guaranteed, guarding against illegal additions or alterations.

2. Encryption: Blockchain networks have the ability to use sophisticated encryption methods to safeguard data, making it difficult for unauthorized parties to view or decode private information.

3. Data Distribution: Blockchain enables data to be distributed over a network of nodes as an alternative to being stored in a single database containing all cancer-related data. As a result, there is less chance of a centralized cyberattack target or a single point of failure.

4. Consensus Mechanisms: Blockchain verifies and agrees upon the data's current state through consensus mechanisms. This increases security by mandating network consensus prior to the addition of any new data.

5. User Control: Individuals can decide who has access to their medical records. People can give different healthcare providers or researchers particular authorization using smart contracts and cryptographic keys.

6. Pseudonymity: Pseudonymous transactions on blockchain enable patients to exchange data without fully disclosing who they are. This enhances privacy protection on top of it.

7. Smart Contracts: Using blockchain technology, smart contracts may automate and enforce agreements between various healthcare organizations on data sharing. This can preserve security and privacy while enhancing interoperability and streamlining data transmission.

8. Visible Transactions: Accountability may be improved by blockchain's visible and auditable features. The blockchain creates a transparent audit trail by recording each transaction and every access to data.

Table 1: Correlations

		Blockchain 1	Blockchain 2	secure privacy-preserving	data management 1	data management 2
Blockchain 1	Pearson Correlation	1	-.041	-.103	-.225	.221
	Sig. (2-tailed)		.778	.479	.116	.123
	N	50	50	50	50	50
Blockchain 2	Pearson Correlation	-.041	1	-.291[*]	-.234	.246
	Sig. (2-tailed)	.778		.040	.101	.085
	N	50	50	50	50	50
secure privacy-preserving	Pearson Correlation	-.103	-.291[*]	1	.014	-.004
	Sig. (2-tailed)	.479	.040		.921	.977
	N	50	50	50	50	50
data management 1	Pearson Correlation	-.225	-.234	.014	1	-.214
	Sig. (2-tailed)	.116	.101	.921		.136
	N	50	50	50	50	50
data management 2	Pearson Correlation	.221	.246	-.004	-.214	1
	Sig. (2-tailed)	.123	.085	.977	.136	
	N	50	50	50	50	50

*. Correlation is significant at the 0.05 level (2-tailed)

The above result describes that correlation analysis between the data management and secure privacy preserving and blockchain. The result describes that 77% relation with block chain 2. The result shows that privacy preservation presents that negative line with blockchain 1,2 respectively.

The data management present 22%, 24%, positive interrelation with each other. Technological breakthroughs have brought about a revolutionary transition in the healthcare industry in recent years. Among them, block chain technology has come to light as a potentially effective way to deal with the issues surrounding the safe and private handling of cancer data.

The Need for a Robust and Secure System to Manage Patient Data:

Since cancer is one of the world's leading causes of death, it is imperative that patient data be managed securely. Unauthorized access, patient control issues, and data breaches have all been problems for traditional centralized systems.

The use of block chain technology offers a paradigm shift in favor of a safer and more patient-centered approach in light of these worries.

Comprehending Blockchain Technology

Essentially, blockchain is a distributed, decentralised ledger system that guarantees data security, immutability, and transparency. Originally intended for use in financial transactions, this technology has found a natural home in the healthcare industry, providing a cutting-edge approach to the safe management and preservation of private medical data.

Ensuring Data Integrity via Immutability

Data immutability is a fundamental characteristic of blockchain technology. Once cancer-related data is stored on the blockchain, it cannot be altered, making it a reliable and unchangeable record. This inherent quality is essential to preserving the accuracy of vital health data.

Decentralization

Redefining Data Security: By doing away with the requirement for a central authority, the decentralized architecture of blockchain technology lowers the possibility of a single point of failure. The dissemination of cancer data among multiple nodes in a network enhances the overall security posture by providing resilience against cyberattacks and unauthorized access.

Patient Empowerment and Privacy Protection

By giving individuals more control over their medical records, blockchain technology empowers patients. People can selectively share their information, protecting privacy and enabling the data sharing required for medical research and treatment through the use of smart contracts and cryptographic keys.

Interoperability with Smart Contracts

Data-sharing agreements are automated and enforced when smart contracts are integrated into blockchain networks.

This promotes a more effective and safe ecosystem by streamlining interoperability between various healthcare providers and guaranteeing that data access complies with established guidelines and authorization.

Transparency and Audibility

Every transaction and access to cancer data is fully documented and verifiable, due to the transparent and auditable nature of blockchain technology. This feature improves accountability in the healthcare system, which is important for preserving stakeholder trust.
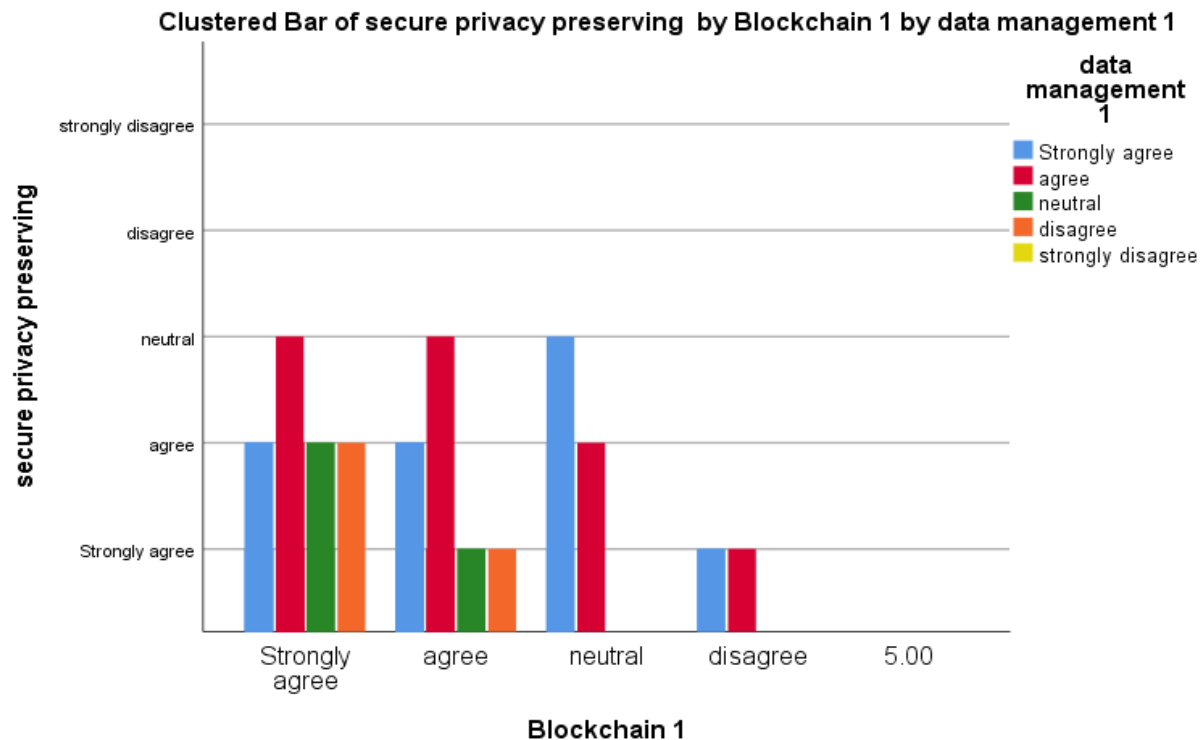
Figure

The above result represents that graph related to privacy preservation by the blockchain. The vertical side presents strong agree, agree, neutral, also that disagree factors related to the variable. the horizontal side presents that strongly agree, agree, the 5.00 level also that the bar line presents the result between them.

Applications

Blockchain technology has a wide range of revolutionary uses in the safe and private storage of cancer data that

affect many aspects of healthcare. The following are a few significant uses that highlight the potential influence of blockchain in this field:

Create a decentralised, impenetrable repository for medical records of cancer patients using blockchain technology. On the blockchain, each patient's medical history, diagnostic results, and treatment plans can be safely kept, guaranteeing data accessibility and integrity while protecting patient privacy.

• Simplify the administration of clinical trials for cancer by securely storing and exchanging trial data via blockchain. In order to improve collaboration while protecting data privacy, smart contracts can automate and enforce the conditions of data-sharing agreements between various research institutes.

• Enable patients, researchers, and healthcare professionals to share data in a transparent and safe manner. Due to blockchain's decentralized structure, important cancer data can be accessed by other entities with the patient's consent, facilitating cooperative research and individualised treatment programs.

• Strengthen the pharmaceutical supply chain's integrity and transparency with regard to cancer therapies. Stakeholders can guarantee the authenticity of pharmaceuticals and lower the probability of fake drugs entering the market by tracking the manufacture, distribution, and delivery of cancer therapies on the blockchain.

• Use consent management systems built on blockchain technology to provide patients visibility into and control over who has access to their cancer-related data. By enforcing predetermined guidelines for data access, smart contracts can guarantee that only individuals or organizations with the proper authorization can use the data for particular purposes with express consent from the patient.

The above-mentioned applications demonstrate the adaptability of blockchain technology in managing diverse facets of cancer data, underscoring its capacity to transform the healthcare sector through its emphasis on security, privacy, and cooperation. More creative uses of the technology are probably to come as it develops, which will help to promote the global transformation of healthcare systems.

Conclusion

In summary, the application of blockchain technology to the administration of cancer data has great potential to completely transform the way that medical records are managed. This study examines the many benefits of blockchain technology, including improved system openness, patient empowerment, and data integrity and privacy assurance. Blockchain shines as an innovative light as we explore the spheres of secure and private healthcare, pointing the way to a time when cancer data

is not only controlled but also protected with unmatched security and privacy. In conclusion, a groundbreaking step towards a future that is more private, secure, and patient-centered has been made with the integration of blockchain technology with healthcare, particularly in the administration of cancer data. A paradigm shifts in how we tackle the complexities of healthcare information is offered by blockchain, which emerges as a beacon of promise in the face of the urgent need for safe cancer data management. Immutability, decentralization, and transparency—the three pillars of blockchain—address long-standing issues with centralized healthcare data systems. Immutability, which guarantees data integrity, guarantees a trustworthy and unchangeable record of patient information, giving medical professionals a strong basis for making decisions. The decentralization of data improves the security posture of cancer data management by removing the vulnerabilities linked to a single point of failure and protecting against cyber threats and unauthorized access. With blockchain technology giving people unparalleled control over their health information, patient empowerment is gaining prominence. Selective data sharing is made possible by the combination of smart contracts and cryptographic keys, which strikes a careful balance between the need to protect patient privacy and the necessity of sharing data for treatment and research. This newfound empowerment builds trust between healthcare providers and the people they serve, and it fits in perfectly with the changing landscape of patient-centric care. Smart contracts automate and enforce predetermined rules and permissions, further streamlining the complex network of data sharing in the healthcare industry. This promotes faster interoperability across healthcare providers and guarantees that access to data follows defined protocols, resulting in a more effective and safer ecosystem for the management of cancer data. Blockchain's auditable and transparent structure adds a level of responsibility to healthcare that has never been seen before. A thorough and verifiable audit trail is produced on the blockchain by each transaction and access to cancer data. This openness fosters trust among interested parties and establishes the foundation for an accountable culture in the healthcare system. There are still issues with scalability, legal compliance, and smooth interface with current healthcare systems.

To successfully navigate the complicated terrain of healthcare data management, technologists, healthcare practitioners, and legislators must work together to overcome these obstacles. Pilot programs and real-world case studies offer concrete proof of blockchain's effectiveness in tackling the particular difficulties associated with managing cancer data. The potential of blockchain technology in healthcare is evident in its various implementations, ranging from the safe exchange of medical information to the secure sharing of

clinical trial data. Observing ahead, it's clear that blockchain technology will play a significant part in managing cancer data in the real world. This is a reality with far-reaching consequences. A new age in healthcare delivery is being ushered in by the continuous breakthroughs in blockchain technology and the increasing recognition of the value of private and secure healthcare data. This momentous occasion marks the coming together of technology and healthcare to create a future where cancer data is not only handled but also protected with unmatched security, privacy, and patient empowerment.

Recommendations

• Encourage cooperation amongst technologists, medical professionals, legislators, and patients. Using a multidisciplinary approach guarantees that the implementation takes into account the various demands and viewpoints of all parties involved.

• Collaborate closely with regulatory agencies to effectively traverse the intricate realm of healthcare regulations. Work together to create frameworks that support innovation in cancer data management while also guaranteeing compliance.

• Foresee and deal with scaling issues early on. Scalable blockchain solutions are going to be crucial as the amount of healthcare data keep increasing. Invest in systems and technology that can manage the growing needs of storing and retrieving cancer data.

• Offer thorough instruction and training on blockchain technology to healthcare practitioners. Comprehending the subtleties of blockchain technology guarantees that professionals can efficiently utilize its potential for managing cancer patient data.

• Create interfaces that are easy to use for both patients and healthcare professionals. Implementing blockchain technology successfully depends on end users interacting with it in a frictionless manner. Adoption and user approval will increase with intuitive interfaces.

• Put strong cybersecurity safeguards in place to fend off possible attacks. Although blockchain improves security, more precautions must be taken to protect against growing cyber threats in the healthcare industry.

• Launch pilot programs to evaluate the viability and efficiency of blockchain in particular cancer data management contexts. Utilize the knowledge acquired from these pilot initiatives to continuously enhance and improve the execution.

• Create and follow interoperability guidelines to guarantee smooth data transfer across various healthcare organizations. The creation of uniform standards will make it easier to incorporate blockchain technology into the current healthcare system.

• Put in place monitoring and assessment systems to continually evaluate blockchain's effects on the management of cancer data. Frequent evaluations will guarantee that the system is continuously optimized and assist in identifying areas for development.

• Give ethical issues a top priority when using blockchain in the healthcare industry. Create and follow moral standards that protect patient confidentiality, permission, and the appropriate handling of private health information.

• Work with the community to spread the word about blockchain's advantages for managing cancer data. Increasing public awareness and trust is essential to the effective implementation of cutting-edge medical technology.

• Provide flexibility in the blockchain implementation design to accommodate upcoming technology advancements. The technology and healthcare industries are changing, and a flexible system will be better positioned to take advantage of new developments.

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