Blockchain Technology in Heath Care: A Bibliometric Analysis and Mapping the Possibilities and Limitations

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https://doi.org/10.5281/zenodo.7771001 HexaTech-VOL2023.CID:037002

Abstract - There are a number of reasons why blockchain technology has maintained its popularity. The primary benefit is that it has paved the way for the widespread adoption of cryptocurrency and other forms of digital payment. Some think the effect of this technology might be even greater than that of cryptocurrency. Scientists have just scratched the surface of blockchain's possibilities. The purpose of this research is to use a bibliometric analysis to undertake a complete examination of blockchain's potential applications in the medical sector. Scopus data was retrieved and examined using VOSviewer. The purpose of this research is to provide a literature review on the topic of blockchain integration in healthcare, and to identify both the opportunities and the challenges that exist in this space.

Keywords - blockchain, internet of things, security, smart contract, privacy, electronic health records.

1 Introduction

Blockchain is often cited as the technology behind the fourth industrial revolution that will fundamentally transform our world [1] et al. Blockchain technology creates a system with no single point of failure or centralized authority. Research on the potential non-financial applications of Blockchain has been ongoing since Bitcoin introduced the technology. Blockchain technology has been greatly impacted by the healthcare sector. The healthcare industry has been immersed in the excitement around Blockchain's transformative potential

[2] et al., There is a growing consensus that blockchain is the best and most urgent healthcare technology capable of addressing the myriad of intricate security and interoperability issues that arise in this sector [3].

Smart contracts, a key component of the "value" and trust-based system, allow for immediate, automated responses to predetermined conditions. However, healthcare is a very intricate system. In this paper, we explain what a blockchain is, how it works, and why it's important for the healthcare industry. Blockchain management, claims adjudication, interoperability, and practicality are also included [4]. Though we have seen blockchain technology in action in a number of contexts, its potential applications and benefits in the healthcare sector are extensively discussed in this study. We also discuss some of the benefits of blockchain technology. We also discussed the challenges and potential benefits of expanding its use to other sectors of the healthcare industry [5]. The limitations and directions for future study into Blockchain applications in healthcare are also covered in this article. The purpose of this study is to identify the potential and barriers to the use of Blockchain technologies in healthcare.

A Blockchain-powered health information exchange may be the key to realizing the full potential of interoperability. Blockchain-based solutions have the potential to decrease or do away with the need for current intermediaries and their associated costs and friction [6] et al. The Precision Medicine Initiative, Care Delivery and Outcomes Research (PCOR), and the Statewide Interoperability Strategy are all compelling use applications for Blockchain technology. In addition, Blockchain technology creates significant ethical and practical questions for the medical community, notably in the areas of data reproducibility, sharing, personal data protection, and patient engagement in clinical trials.

When it comes to the Internet, the Blockchain is helping to move us closer to decentralization. Serious repercussions for the well-being of the Blockchain are anticipated. This is an exciting moment for the healthcare and IT industries [7] et al. As a consequence of breakthroughs in genetics and clinical research, the medical industry is adopting novel strategies for the prevention of disease. Blockchain technology may offer a new institutional setting for magnifying and facilitating the unification of health care data across many applications and stakeholders, but it is not a panacea for data standards or system integration issues. In addition to addressing a variety of issues, it also improves the system's efficacy, decentralization, and security. The blockchain system is a revolutionary development [3]. Therefore, in order to successfully deploy technology for the largest outcome, which can be investigated and assessed from a socio-technical perspective, a significant therapeutic shift is necessary. Technology is only going to help us more as it advances and we learn to better use it. When figuring out how to improve Blockchain, it's important to think about the societal and technological challenges it faces. Technology is employed in healthcare for the best possible outcomes.

2 Review of Literature

To put it simply, a Blockchain is a special kind of database. Blockchains are not like traditional databases in that information is not stored in one large database but rather in individual blocks that are connected together [7] et al. Every time new information is added, another section is added. With the use of Blockchain Technology, a large group of individuals may collaborate as validators to reach consensus on a wide range of issues, including the legitimacy of transactions [8]. Mathematical verification confirms the effectiveness of this method, and it is used to keep networks safe.

In a word, Blockchain is a kind of distributed ledger technology (DLT) that enables a decentralized, shared database to exist over a network of thousands of machines in which all users have instantaneous access to all data [9]. It's based on decentralized networking technology called P2P. It becomes more challenging for the user to control the network or the game [10] et al. Members who lack self-assurance must reach consensus on the distributed nature of the network [11] et al.

One of the main characteristics that sets Blockchain apart as a revolutionary healthcare technology is its decentralized nature [12] et al. This is because information storage (a database) is still conceptualized as an actual thing rather than a digital one. Moreover, the risks of data loss, mishandling, or inadvertent deletion from manual record keeping are very significant since information is a physical thing [3]. One of the biggest challenges for Blockchain healthcare applications is ensuring the security of the underlying network architecture at every level. All participants have their identities verified and vetted. Electronic health records need authorized access in a consistent manner.

On the other side, if Blockchain technology were to be used, a centralized administrator wouldn't be needed since their responsibilities might be replaced by cryptography. It is possible that the Blockchain might be used to restructure this medical database and make safe distribution possible, since the healthcare industry depends on quick access to a patient's data while yet keeping the information private and hidden [13]. So, the system is scalable, data is secure, and it's easy to access. Although the use of Blockchain technology in healthcare might cause some disruption, it will never be a magic bullet for fixing existing database issues. Instead, it might turn out to be a fantastic journey toward widespread use of Blockchain technology.

However, if Blockchain technology were to be implemented, a centralized administrator would no longer be necessary, since cryptography could do all of that role. Given the need of speedy access to patient data without compromising confidentiality, the Blockchain might be used to restructure this medical database and facilitate safe transmission [14] et al. Thus, the system is both scalable and secure while also being easily accessible. While Blockchain technology's adoption to the healthcare sector may cause some upheaval at first, it will never

be a magic bullet for fixing existing database issues. Instead, the implementation of Blockchain may turn out to be a fantastic journey.

Healthcare providers have a major difficulty in ensuring the security and accessibility of the vast amounts of sensitive patient information generated in the course of daily operations [15] et al. Wearables and other healthcare monitoring technology produce enormous volumes of sensitive personal health data. Most health data is not easily available, is not standardized across systems, and is difficult to comprehend, utilize, and share [16]. They are collected from many sources and kept in consolidated IT systems, both of which make it difficult to manage and share. The process of requesting, transmitting, receiving, and synthesizing patient data is laborious and resource intensive. When stored and retrieved securely, this information allows healthcare systems to form more complete portraits of their patients, which in turn leads to better care, more effective communication, and better overall health.

Inadequate interoperability, inaccessible hospital records, and inadequate and insecure population health data are further issues plaguing the healthcare sector. Recent public health emergencies have brought into focus the present healthcare system's lack of interoperability [10] et al. Furthermore, the healthcare business has a serious problem with the protection of patient data. Many healthcare companies have centralized storage of sensitive patient data in their old legacy IT systems, making them easy prey for ransomware and other forms of assault.

Recently, there has been an initiative to make health data interchange the responsibility of the individual patient, known as patient-driven interoperability. But healthcare is only starting to establish the infrastructure, software programs, and strategic procedures that can bring together the many kinds of data they have access to in a dependable, safe, and consistent manner [17] et al. Patient privacy, data integrity, quality, and accuracy are only some of the problems with today's healthcare information systems. The healthcare sector is exploring the potential offered by new technology in order to address these pressing issues [18]. Therefore, there is a need for cutting-edge technology that can speed up the transition to interoperability that is focused on the individual patient [16]. Patients should be at the core of the care continuum, and blockchain technology may help alleviate some of the interoperability problems that have arisen.

3 Methods

The researcher in this study only looked for literature that was published in journals or presented at conferences that were included in the Scopus database. Health-related articles pertinent to British Columbia could only be found during the last five years. We utilized a search method that looks for the following phrases in paper titles, abstracts, or keywords to get articles from the chosen database: blockchain AND (health, medicine, biomedicine, clinic, doctor, pharmaceutical, sick, hospital, diagnosis, insurance, patient, wellness, disease, disability, treatment, prognosis, medication, surgery, etc.). Each author performed their own search of each publication's title, abstract, and keywords to guarantee that the papers included

were all relevant conceptually. When there were disagreements about the ratings, the relevant articles were debated until a consensus was achieved. Therefore, in order to exclude any possibility of bias, at least two writers independently reviewed the complete texts of all possibly relevant research. Thirty total articles and conference papers were gathered for the final tally.

4 Results

Figure 1 shows that old-fashioned database stores its information in a centralized location, such as a server (or network of servers) managed by a single person. In contrast, blockchain is a method of data management in which records are added to a shared electronic ledger across a decentralized network of computers.

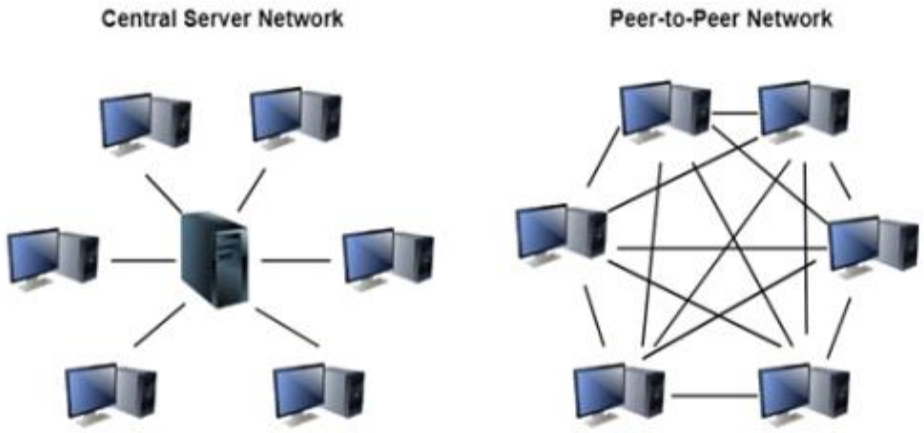

Fig. 1. Centralized versus a distributed, peer-to-peer network;
Source: HIMSS Blockchain Networks Overview (HIMSS, 2019)

Blockchains are digital ledgers that may record and store digital information in blocks, such as those used to keep track of financial transactions or medical histories [19] et al. When all of the necessary information for a block has been submitted, that block is appended to the existing chain of blocks, and a new block is made ready for the next set of inputs. Blockchains are distributed ledger technology that can accommodate an infinite number of users in a single network, such as a worldwide marketplace for medical supplies [20] et al. As blocks are added to a blockchain, everyone involved receives an updated and synchronized copy of the blockchain automatically. A node is any computer or other device that holds or offers access

to a copy of the blockchain. Each member of the blockchain network may see the whole chain of records.

Three out of a total of seven clusters have been singled out using the clustering method. Figure 2 represents the network diagram that appeared in the research literature. Word frequency and keyword association are seen using the cloud map. Each phrase is represented in the network by a circle, the size of which corresponds to the total number of occurrences of that term throughout all publications. The length of curved lines indicates a rough approximation of the relationship between the repetition of the phrase, and the thickness of ones indicates the strength of pairings of subject areas or keywords.

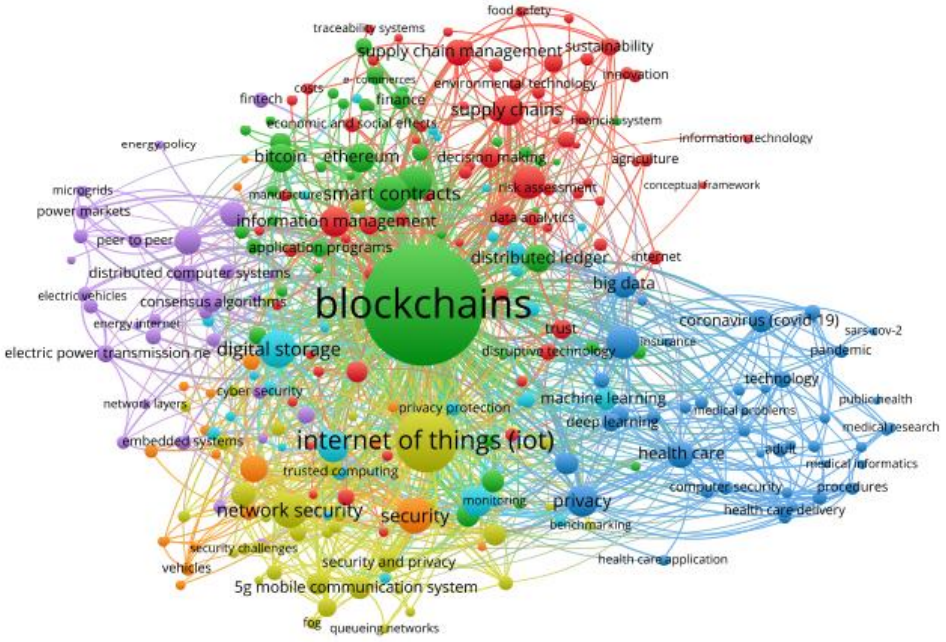

Fig. 2. Network visualization

There has been a rise in the number of articles discussing the possible uses of blockchain technology in the healthcare sector, however at now, the field is still developing [21] et al. Figure 3 shows that few studies include any technical details on the blockchain components used, and even fewer explain a prototype or pilot application from which to learn. Healthcare blockchain implementations on a national scale are still in their infancy. Better data security and less complicated patient permission management are only two of the benefits that have resulted from the usage of blockchain technology in certain countries.

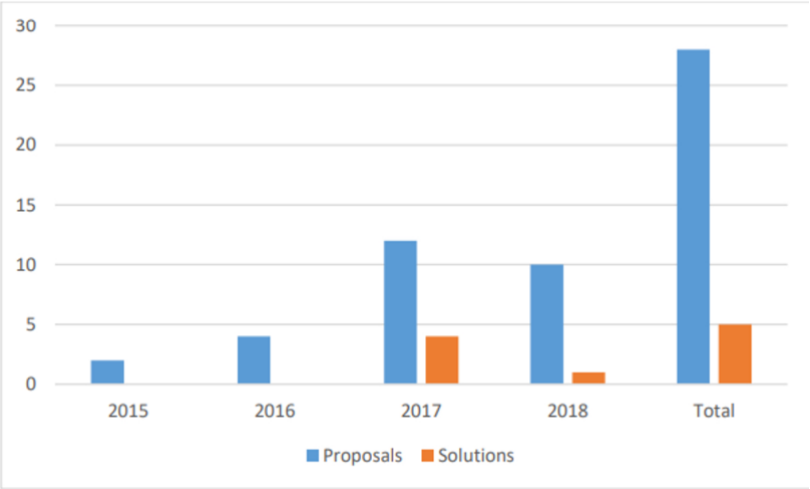

Fig. 3. Most past papers show proposal instead of solution.
Source: [22]

Figure 4 shows that Current healthcare research in Blockchain focuses on topics such as blockchain, electronic health records (EHRs), privacy, smart contracts, the internet of things (IoT), and security. Since their introduction, electronic health records (EHRs) have caused a sea change in the healthcare industry, revolutionizing the way information on patients and their treatments is kept and shared. Access to up-to-date information in a timely manner is made possible by EHR, which may help enhance and bolster patient-centered treatment [7] et al. On the other hand, rising worries about the security and confidentiality of medical data in e-health systems may outweigh the advantages of EHR. In order to address these issues, BCT facilitates the sharing of electronic health record (EHR) information between patients and healthcare providers. Because of BCT, patients may access their electronic health records (EHRs) without relying on their healthcare professionals or other websites for treatment. By centralizing EHRs on BCs, users may improve operational efficiency, raise responsibility for data management among themselves, open up new channels for the safe exchange of healthcare data, and boost interoperability across healthcare institutions.

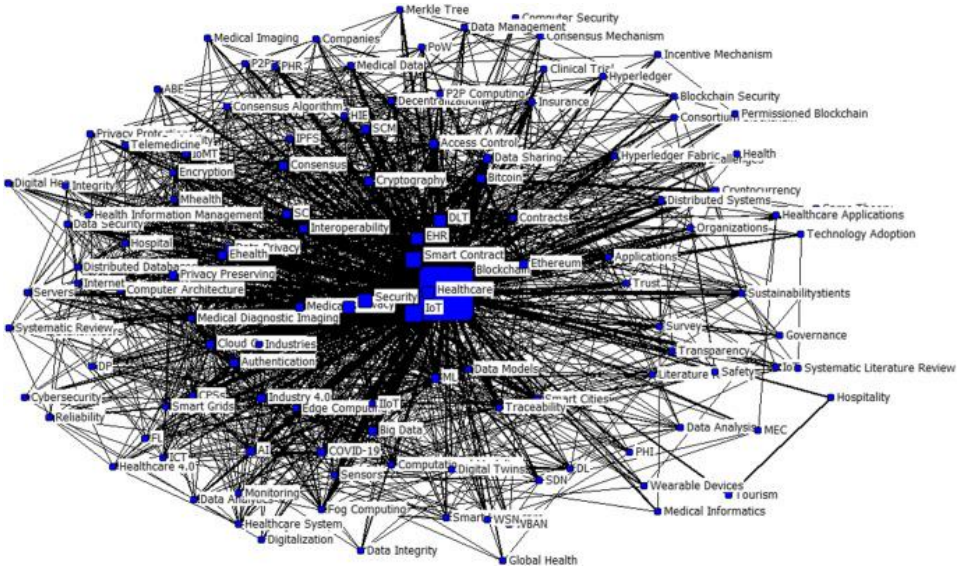

Fig. 4. Keyword co-occurrence network

4.1 Potential of Blockchain in healthcare

COVID-19. Blockchain technology has had a profound impact on the healthcare industry, one of the most crucial in existence [23] et al. When used together, AI and blockchain provide a wealth of implications for resolving real-time settings, while an adaptation of blockchain for use in big data analytics may zero in on data quality. With blockchain, all participants in the healthcare value chain may safely and securely exchange network access without jeopardizing the privacy or confidentiality of patient information.

The healthcare business is undergoing fast transformation due to the significant difficulties, concerns, and possibilities presented by technological advancements. In the first place, it is no longer a partnership between pharmaceutical corporations, government agencies, and licensed medical practitioners [24] et al. Tech companies are entering the healthcare market with the goal of improving both patient access and the quality of care offered at a reasonable cost. Research and development spending is shifting more toward consumer health by these corporations.

Second, we are cared for only after we get ill, with the current healthcare system focusing on treating symptoms rather than addressing the underlying causes of illness. COVID-19 may be hastening the transition to continuous healthcare, whereby complex, data-driven choices replace the current system [23] et al. Finally, sensors in wearables offered by digital giants

like Google, Apple, Amazon, and others are constantly monitoring vital signs including heart rate, temperature, breathing sounds, heart rate variability, and step count around the clock.

When the benefits of openness and immutability outweigh the costs of extra data storage, blockchain is the technology of choice for recording transactions [25]. The size of the data blocks might be minimal, and there should be a low level of trust among network users, and this is where it excels. Verification of identity among suppliers and patients; supply chain management; and dynamic patient permission to data usage are all areas where blockchain may be very valuable in the healthcare industry [26]. Unfortunately, blockchain is not well adapted to storing vast volumes of data due to the computational and capacity restrictions of replicating the blockchain across every participant in the network. Large datasets, such comprehensive electronic health records or genetic data, are impractical and expensive to store on the blockchain.

Good health outcomes rely on the precise and reliable identification of persons and institutions. Safer identification is possible because to the blockchain's ability to increase data integrity and openness while countering identity versioning [27]. A thorough pairing of this data, for example with individual's electronic patient records, will become increasingly important as more data continues to flow via wearable smart devices and Internet of Things (IoT). Providers of health care services (including persons and organizations) need to make sure that their contact information is correct and up-to-date so that patients can locate them, they can be accredited, and they get fair payment. It's possible that the essential data's correctness and dependability might improve if it were kept on a blockchain.

By utilizing their own passwords and encryption key, people may provide third parties open, auditable access to their health records stored on a blockchain [21] et al. In a universe where digital information can be utilized and re-used eternally and new research enquiries and motivations for data use continually develop, the progressive or "dynamic" permission given by blockchain is an essential option to "once-only" consent paradigms. The addition of a new block to the chain will overrule any previous blocks, making it possible to amend a person's rights and consents at any time [28].

The pharmaceutical industry has trust concerns in its supplier networks. Issues of intellectual property protection, quality assurance, counterfeiting, and drug trafficking are among them. The immutability of the blockchain's records makes it a promising tool for establishing the bona fides of both sellers and buyers [1] et al. Products are timestamped and placed on a blockchain for monitoring and verification in the Hyper ledger Counterfeit Medicines Project, for instance [29] et al. Another developing issue area that might benefit from the openness and immutability enabled by blockchain technology is ensuring enough supply and preventing shortages of pharmaceuticals. Chinese hospitals are using blockchain technology to keep track of patients on the Covid-19 study and provide them their medicine on schedule.

The supply chains for medical devices faces similar dangers. Safety and efficacy concerns, as well as a history of security flaws in high-risk devices, may all fall into this category. After standardized procedures have been established, a blockchain might be used to increase their veracity, transparency, and safety. During the Covid-19 epidemic, it will be crucial to coordinate the distribution of personnel, inpatient beds, intensive care unit beds, and other essentials among various healthcare facilities and agencies [4]. When dealing with situations requiring high levels of trust or restricted access to shared data, blockchain technology may prove to be an efficient solution [26]. However, it is important to note that this technology is most effective when used in tandem with other solutions, such as a comprehensive health data infrastructure and information system, in order to accomplish policy objectives.

4.2 Limitations of Blockchain in healthcare

Blockchain technologies garner interest because they introduce novel approaches to the exchange of value, the representation of digital assets, and the embodiment of trust mechanisms; however, it remains challenging to develop a phased approach to observing various options to guarantee successful enterprise production outcomes [30] et al. Blockchain is making significant progress, but there are still business difficulties and technological gaps that must be addressed before it is ready for general adoption. Blockchain technology may be used in a highly adaptable setting, allowing for the development of potent smart contracts that serve as a universal infrastructure for a wide range of uses, including electronic government.

Given the importance of preserving individuals' privacy, OECD nations have passed laws to limit the collection, use, and disclosure of individuals' health information. Even if records were de-identified, storing them "on chain," where they would be available to all other network members, would pose a serious danger to data privacy [4]. However, there are data privacy problems even with the technically possible option of keeping metadata on personal health data (data about data) on chain, since this data might be used to inadvertently disclose patient names and cannot be deleted.

All users are not assumed to have top-of-the-line computers and other peripherals. The majority of consumers also lack familiarity with cutting-edge tools. There are a lot of senior citizens who don't have a clue how to operate a computer, and that includes both men and women. In order to mine cryptocurrencies, a graphics processing unit (GPU) is needed, and not all laptops have one. In many ways, this is blockchain's greatest obstacle.

The usage of paper records is still common among consumers and medical professionals. They favor using a filing system to store patient information. Not all pharmacies have made the transition to paperless operations [24] et al. In order to maintain track of their inventory, most drugstores rely on prescriptions. The patients also preserve the documents for future reference. Consequently, transitioning to a blockchain-based, paperless system is a difficult endeavor.

Most medical services nowadays are provided via decentralized networks. Multiple locations are home to many hospitals. Therefore, keeping up with a blockchain may be a demanding job. Without a centralized database, it is difficult to use blockchain for medical records [1] et al. Take the case of someone who goes to a hospital labeled "A" in state X. He may go to Hospital 'A' again, but maybe in a different part of the city next time. In order to accommodate the two distinct geographies, two separate blockchains have been created. This means that getting your hands on your old medical records will be a major hassle.

5 Conclusions and Discussion

The hype around blockchain technology's promise in the healthcare industry may make its actual utility difficult to pin down. Lack of data interoperability and the requirement for health data governance remain among the greatest challenges to the digital transformation of the health industry, and they are not eliminated by blockchain technology [7] et al. To store information, blockchains do not need a centralized authority, but this does not mean that authorities are unnecessary. Due to the sensitive nature of health data, blockchain applications in this industry will need strict monitoring and adherence to industry norms and regulations. Any blockchain's governance mechanism, the consensus system, is not technological but rather relies on the agreement of its users.

Since Blockchain is such a radical departure from the status quo in terms of data management and storage, it is crucial that all relevant parties be kept in the loop during the implementation process [3]. The health personnel would need to be educated and trained in order to make the most of this technology [31]. Stakeholder engagement and information to enlighten patients on how to use the technology and their rights and obligations are crucial to ensuring a smooth rollout when it's time to install the technology to provide patients more authority over and access to their data.

The blockchain's immutability has both positive and negative implications. At now, it is impossible to remove health-related information from a blockchain. It is possible to erase data from storage off-chain, but the blockchain will always include a record that such data ever existed. There is a legal issue of whether or not the metadata constitutes personal health data because of the sensitive nature of the material. Masking blocks with a certain signature is one potential technical answer, but the field is advancing quickly and there may be others.

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