Could Blockchain Revolutionize Data Management in the Healthcare Industry?

Jonathan Lawrence
Bellevue University
Dallas, TX 75287, USA
Jonathan.lawrence215@gmail.com

Abstract
This research paper's purpose is to identify the potential benefits of implementing security solutions that utilize blockchain technology when dealing with the management and security of medical data. By studying current issues in the handling of medical data, it becomes apparent how blockchain technology can be implemented to rectify those issues. The resulting study shows both positive and negative aspects of blockchain technology and weights the advantages against the disadvantages.

Author Keywords
Blockchain; Data Quality; Data Storage; Data Protection; Access; Electronic Health Records

ACM Classification Keywords
J.4 Life and Medical Sciences

Introduction
With the rise of the Internet of Things (IoT), the type of data we gather has increased exponentially creating a need for new data management methods.[1] Within the last ten years, the healthcare industry has witnessed a massive migration from paper records to electronic records for patients' medical data. Proper measures

must be implemented to guard against data loss including theft, unauthorized access, and misuse of records, as well as utilization of secure storage facilities.[2] Blockchain, a relatively new technology, may be the solution to solving these problems.

Introducing Blockchain Technology

There is a need for a decentralized, transparent, secure approach to sharing medical records electronically. Most transactions are centralized by a third-party organization, often requiring a middleman. Blockchain's goal is to revolutionize how data is handled. Widely known for its origin in Bitcoin, the technology provides security, anonymity and data integrity.

Blockchain is a distributed database solution that maintains a dynamic storage of data that is validated by all nodes participating in the blockchain.[3] Since there is no third-party organization involved, the data is recorded in a transparent, public ledger that is visible to all nodes, except the data within is kept anonymous. Figure 1 on page 3 shows a comparison between existing centralized networks, decentralized networks, and blockchain-based decentralized networks.

In order for a blockchain to work, nodes on the network have to record every transaction into a block. [4] Once the block is filled, the nodes perform mathematical operations that are difficult but the correct solution can be verified with ease. The first node to solve the mathematical operation broadcasts it to all nodes, who validate the accuracy of the solution. Once 51% of the network's processing power has validated the solution, the nodes record the transaction to a new block.

Issues Surrounding the Management of Medical Data

While currency and payments may be the most obvious applications of blockchain, the medical industry could largely benefit as well. [5] Most medical records are still stored on paper, presenting a few difficulties when attempting to coordinate care, ensuring quality of the records, and decreasing the chance of medical errors. [6] There are cases where a patient's confidential medical data is at risk of exposure, and this presents legal and financial risks to healthcare providers. [7] These are all side-effects that stem from improper management and access to medical records.

Customers tend to move towards high-security providers when seeking stronger data protection. [8] However, these providers tend to charge higher prices while not disclosing their security practices. Customers are left to assume that the provider is properly managing their data without any oversight. This leads to scenarios where healthcare providers may omit data breaches from the public eye in order preserve their image. In fact, a study found that twenty-six percent of adults in the US, or an estimated 64 million, recalled receiving a breach notification over a 1 year period. [9]

In a nationally representative survey known as HINTS, or Health Information National Trends Survey, aimed at collecting information regarding American's need for, and access to, health information, Oxford Academia reported that 75.4% of patients had confidence that healthcare providers instilled safeguards to protect their personal health information from unauthorized access. [10] However, their main concern was the potential for security breaches when transitioning their data between providers. Of all consumers who were

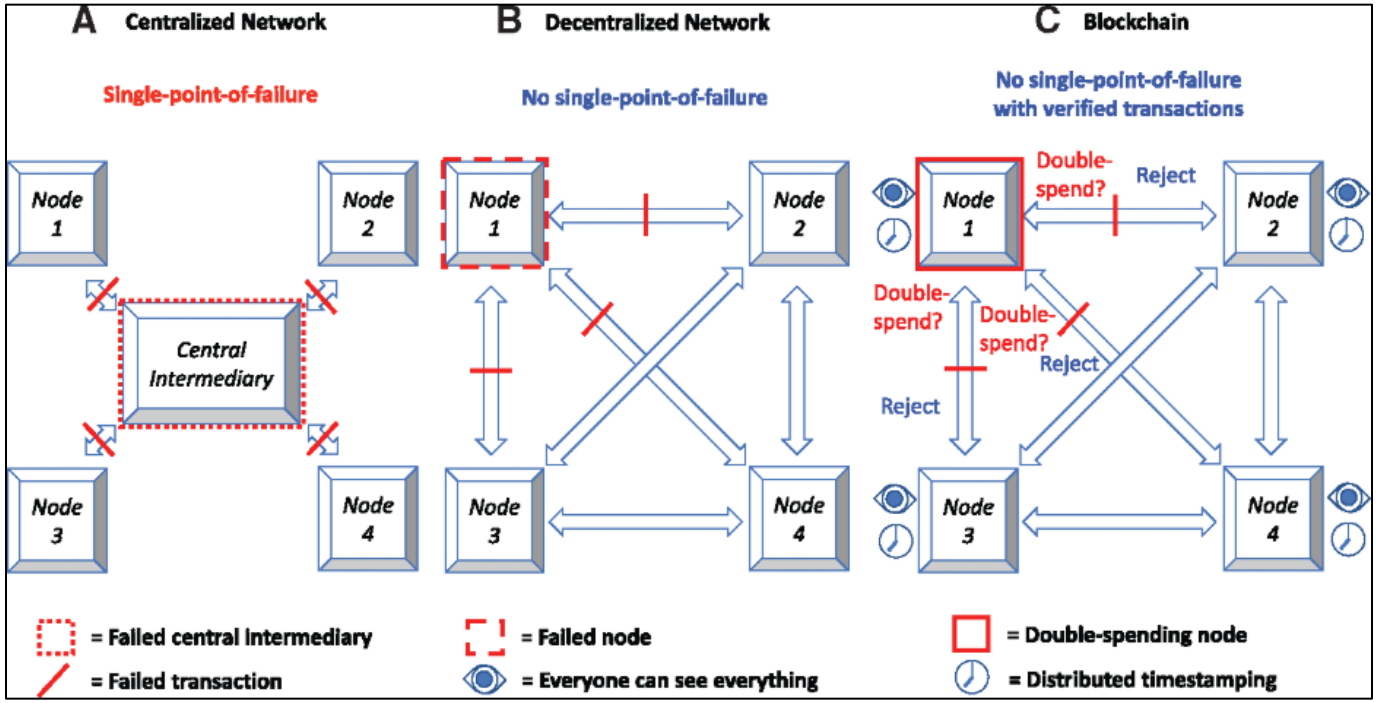

Figure 1: Comparison of the distributed network topologies.

surveyed, 67% were concerned about sending their records between providers over fax.

Blockchain's Potential in the Medical Industry

While relatively new, blockchain technology is already seeing developments in the areas of applications and services that involve intellectual property, identity management, and decentralized services such as for domain name systems (DNS). [11] This instills a desire to use these achievements by developing a blockchain-based access control method that encompasses inherent blockchain benefits including, protection of access to stored medical data, enabling efficient sharing of that data, decentralized management, immutable audit trail, data provenance, security, and privacy.

A lightweight, blockchain-based wrapper has been proposed for conventional databases to offer notary services. The service would be able to provide immutable proof that the data was retrieved, what the specific query was, and who placed it, thus ensuring that the consumer's query transaction was not affected by anything malicious.[12] The blockchain service is the proposed component which would act as a mediator between existing databases and the consumers.

Utilizing blockchain technology could also vastly decrease the cost of verification and networking.[13] Its ability to verify transaction details such as who, when, and where, along with its innate data integrity and exclusion of costly intermediates play a key role in understanding how patient-driven interoperability would be improved through blockchain technology.

Another application includes automated health claims adjudication – using blockchain to support enabling concepts such as "disintermediation and trustless exchange" using a "smart contract" structure, and online patient access.[14] A smart contract is a piece of code that acts similar to a contract between any two individuals.[15] In other words it is a combination of code and data that exists at a specific location in the blockchain, and which is cryptographically validated by the rest of the network [16] This would be built on Ethereum, a blockchain 2.0 technology capable of utilizing the operation of smart contracts[17], and maintained by regulators such as the Food and Drug Administration (FDA) and other research organizations.

Issues Facing Blockchain

Blockchain is a new technology with a few unrefined components. It requires a massive amount of energy consumption in order to provide constant validation checks for all the data in the chain. [18] Blockchains are also susceptible to the Majority Attack, otherwise known as 51% Attacks. If a single entity were to gain control of 51% of the computing power in a blockchain, it could take control of the blockchain and do whatever it saw fit to the data.

As of February 2016, the size of a blockchain in the Bitcoin network was over 50,000MB, which could increase by 214PB each year if it increases to the levels of VISA. [19]

Additionally, there is some concern regarding Blockchain's 'new' status. Professor Garrick Hileman from the London School of Economics observed "Because of the weight of various historical indicators and in the wake of significant recent events, regulators adopted an incredibly aggressive approach to enforcing existing regulations against the drastically new, different, and emerging technology." [20] Perhaps laws and regulations could be programmed into the blockchain to be enforced automatically.

Conclusions

We've discussed how Blockchain works, how it can revolutionize data management in the healthcare industry, and discussed some potential issues. Blockchain could provide expedited medical records transfers, access controlled by patients, and a secure framework to reduce the risk of the data being tampered with. While Blockchain poses a few drawbacks, it's still in an early state. If the technology improves to eliminate those factors, then blockchain has the potential to revolutionize the healthcare industry by changing how data is managed.

Acknowledgements

I gratefully acknowledge Catie Williams for her steadfast assistance with this project, my DSC500 classmates for tremendous discussions regarding topics of interest and understanding, and the inventor of Blockchain operating under the alias of "Satoshi Nakamoto".

References

1. Ivan, D. (2016, March 6). Moving Toward a Blockchain-based Method for the Secure Storage of Patient Records. Retrieved January 24, 2019, from https://www.healthit.gov/sites/default/files/9-16-drew_ivan_20160804_blockchain_for_healthcare_final.pdf
2. Wikina, S. (2016, March 6). What Caused the Breach? An Examination of Use of Information Technology and Health Data Breaches. Retrieved January 24, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4272442/
3. Yli-Huumo, J. (2016, October 3). Where Is Current Research on Blockchain Technology?—A Systematic Review. Retrieved February 13, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5047482/
4. Ammous, S. (2016, September 01). Blockchain Technology: What is it Good for? Retrieved February 13, 2019, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2832751
5. Swan, M. (2015). Blockchain: Blueprint for a New Economy(2nd ed.). Stebastopol, CA: O'Reilly. Retrieved February 13, 2019, from https://books.google.com/books?hl=en&lr=&id=RHJmBgAAQBAJ&oi=fnd&pg=PR3&dq=blockchain&ots=XQuID13Te5&sig=t5vWLeXVgXYjdD7TgW7_f8M6VtE#v=onepage&q&f=false.
6. Hillestad, R. (2005, September 6). Can Electronic Medical Record Systems Transform Health Care? Potential Health Benefits, Savings, And Costs. Retrieved February 13, 2019, from https://www.healthaffairs.org/doi/10.1377/hlthaff.24.5.1103
7. Kamoun, F., & Nicho, M. (2014, January 01). Human and Organizational Factors of Healthcare Data Breaches: The Swiss Cheese Model of Data Breach Causation And Prevention. Retrieved February 13, 2019, from https://www.igi-global.com/article/human-and-organizational-factors-of-healthcare-data-breaches/110185
8. Kwon, J., & Johnson, M. E. (2016, October 3). The Market Effect of Healthcare Security: Do Patients Care About Data Breaches? Retrieved February 13, 2019, from https://pdfs.semanticscholar.org/f3c4/2d80583f5d87957a9dbd8bf0bdd4db3c279d.pdf
9. Ablon, L. (2016, November 16). Consumer Attitudes Toward Data Breach Notifications and Loss of Personal Information. Retrieved February 14, 2019, from https://books.google.com/books?hl=en&lr=&id=zFobDAAAQBAJ&oi=fnd&pg=PP1&dq=medical data breach&ots=Re6ulTKkfh&sig=fwP6fghE7BFqI674_wCkwZXrJwE#v=onepage&q=medical data breach&f=false
10. Adisa, A., Connolly, & N, G. (2013, August 23). Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers. Retrieved February 13, 2019, from https://academic.oup.com/jamia/article/21/2/374/725094
11. Kuo, K., Hyeon-Eui, Ohno-Machado, & Lucila. (2017, September 08). Blockchain distributed ledger technologies for biomedical and health care applications. Retrieved February 13, 2019, from https://academic.oup.com/jamia/article/24/6/1211/4108087?searchresult=1
12. Xia, Q., Sifah, E. B., Smahi, A., Amofa, S., & Zhang, X. (2017, April 17). BBDS: Blockchain-Based Data Sharing for Electronic Medical Records in Cloud Environments. Retrieved February 13, 2019, from https://www.mdpi.com/2078-2489/8/2/44

13. Gordon, W. (2018, June 30). Blockchain Technology for Healthcare: Facilitating the Transition to Patient-Driven Interoperability. Retrieved January 24, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6068317/

14. Stagnaro, C. (2017, July 13). White Paper: Innovative Blockchain Uses in Health Care. Retrieved January 24, 2019, from https://www.freedassociates.com/wp-content/uploads/2017/08/Blockchain_White_Paper.pdf

15. Rifi, N. (2018, December 05). Blockchain Technology: Is It a Good Candidate for Securing IoT Sensitive Medical Data? Retrieved February 13, 2019, from https://www.hindawi.com/journals/wcmc/2018/9763937/

16. Nugent, T., Upton, D., & Cimpoesu, M. (2016, October 20). Improving data transparency in clinical trials using blockchain smart contracts. Retrieved February 13, 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5357027.1/

17. Davis, J. (2016, November 16). Peer to Peer Insurance On An Ethereum Blockchain. Retrieved February 13, 2019, from https://nebula.wsimg.com/1ea036de40121e9a7d9798eca609eeb3?AccessKeyId=4EC7FC0F7E7F5389BE71&disposition=0&alloworigin=1

18. Lin, I., & Liao, T. (2017, January 12). A Survey of Blockchain Security Issues and Challenges. Retrieved January 23, 2019, from https://pdfs.semanticscholar.org/f61e/db500c023c4c4ef665bd7ed2423170773340.pdf

19. Yli-Huumo, J., & Ko, D. (2016, October 3). Where Is Current Research on Blockchain Technology?-A Systematic Review. Retrieved February 13, 2019, from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0163477

20. Trautman, L. J. (2016, May 31). Is Disruptive Blockchain Technology the Future of Financial Services? Retrieved February 13, 2019, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2786186