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BLOCKCHAIN IS THE KEY TO FACILITATING THE HEALTHCARE SYSTEM

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I. Introduction

The healthcare industry is one of the world’s largest industries, accounting for 17.7% of the United States Gross Domestic Product (GDP).¹ Unsurprisingly, the health spending share is projected to rise from 17.7 percent, as reported in 2018, to 19.7 percent by 2028.² The U.S. spends more on healthcare than any other country in the world.³ Being that we spend the most on healthcare, one would assume that we are the healthiest nation in the world. Unfortunately, despite the highest spending, “Americans experience worse health outcomes than [our] international peers.”⁴

It is time for the United States to take appropriate measures to reduce healthcare spending and improve the overall healthcare experience. Without an initiative for greater efficiency and innovation, the cost of the U.S. healthcare system will continue to rise. While there are several flaws within our current healthcare system, this paper will discuss how blockchain technology has the capability to revolutionize the healthcare industry. Accordingly, part II of this paper will provide an overview of blockchain; Part III will explain blockchain’s popularity; Part IV will discuss three critical areas plaguing our current healthcare system; Part V will analyze current healthcare services; Part VI will explain how healthcare will benefit from blockchain; and Part VII will analyze legal implications that may arise.

II. Overview of Blockchain

¹ *National Health Expenditure Fact Sheet*, Centers for Medicare & Medicaid Services (2020), <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NHE-Fact-Sheet>.

² *Id.*

³ Roosa Tikkanen, *U.S. Health Care from a Global Perspective, 2019: Higher Spending, Worse Outcomes?*, The Commonwealth Fund (Jan. 30, 2020), <https://www.commonwealthfund.org/publications/issue-briefs/2020/jan/us-health-care-global-perspective-2019>.

⁴ *Id.*

Blockchain is a term we hear far too often but who really knows what it means? A blockchain is an immutable public ledger for recording transactions – imagine a large excel sheet.⁵ Each transaction within a blockchain is immutable, meaning that it cannot be modified after it is created.⁶ Once data is inserted onto the blockchain, it becomes permanent and cannot be modified at a later date – not even by the original authors – without the alteration of all subsequent transactions.⁷ Furthermore, each block within the chain is both its own independent unit containing its own data, and a dependent link in the collective chain, and this duality creates a network regulated by participants who store and share the information, rather than by a third party.⁸ In other words, a blockchain is, in the simplest of terms, a time-stamped series of immutable records of data that is managed by a cluster of computers not owned by any single entity. Each of these blocks of data (i.e. block) is secured and bound to each other using cryptographic principles (i.e. chain).⁹ A blockchain is a secure system for sharing and storing data due to its transparency.¹⁰ In other words, a blockchain is secure because there is no centralized structure for a malicious user to target, as the data is stored in numerous copies on different computers. These properties render blockchain ideal in healthcare data management.

III. Blockchain's Popularity

Blockchain gained significant popularity as a distributed ledger technology following the publishing of the Bitcoin white paper in 2008, which opened the door to endless innovations.¹¹ The white paper was written by an unidentified individual, or group of individuals, under the

⁵ Niaz Chowdhury, *Inside Blockchain, Bitcoin, and Cryptocurrencies* 4 (2019).

⁶ *Id.*

⁷ *Id.*

⁸ *Id.*

⁹ Ameer Rosic, *What is Blockchain Technology? A step-by-step Guide for Beginners*, Blockgeeks (2016), <https://blockgeeks.com/guides/what-is-blockchain-technology/>.

¹⁰ Hannah S. Chen, Juliet T. Jarrell, Kristy A. Carpenter, David S. Cohen, and Xudong Huang, *Blockchain in Healthcare: A Patient-Centered Model*, Biomedical Journal of Scientific & Technical research (Aug. 8, 2019).

¹¹ Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System* (2008), www.bitcoin.org.

alias Satoshi Nakamoto.¹² The blockchain, as we now know it, first manifested in 2009 as a core component of the cryptocurrency Bitcoin.¹³ While the term “blockchain” is often used interchangeably with the term “Bitcoin” or “cryptocurrency,” the fact is that blockchain is actually the foundation, which allows for a cryptocurrency such as Bitcoin to exist.¹⁴

IV. There are three critical areas plaguing our current healthcare system, which establish the need for greater efficiency and innovation.

a. Highest Health Care Spending in the World

The American healthcare system is terribly flawed by ineffective practices. Yet, Americans spend more for health care – and receive less – than people in other developed countries.¹⁵ The U.S. health care spending grew 4.6 percent in 2018, reaching \$3.6 trillion or \$11,172 per person.¹⁶ The United States healthcare spending steadily increases every year and will continue to increase unless we allow for greater efficiency and innovation, a solution that can be found with blockchain technology.¹⁷

b. Interoperability of Patient Data

Today, blockchain technology has the potential to transform the healthcare industry by increasing the security, privacy, and interoperability of patient data. The healthcare industry relies on multiple sources of information, such as clinics, laboratories, pharmacies, hospitals, and

¹² *A Blockchain Glossary for Beginners*, Consensus (2020), <https://consensus.net/knowledge-base/a-blockchain-glossary-for-beginners/>.

¹³ *Id.*

¹⁴ A cryptocurrency is a digital currency that uses cryptography for security. See Nakamoto (2008).

¹⁵ *U.S. Health Care Spending Highest Among Developed Countries*, John Hopkins Bloomberg School of Public Health (Jan. 7, 2019),

<https://www.jhsph.edu/news/news-releases/2019/us-health-care-spending-highest-among-developed-countries.html>.

¹⁶ *Historical*, U.S. Center for Medicare & Medicaid Services (Dec. 17, 2019), <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical>.

¹⁷ *Trends in health care spending*, American Medical Association (Mar. 3, 2020), <https://www.ama-assn.org/about/research/trends-health-care-spending>.

primary care providers, which typically use multiple systems to record patient data.¹⁸ A blockchain can allow improved interoperability as data across multiple systems can be exchanged and accessed simultaneously.¹⁹ This technology could provide a new model for health information exchange (HIE) by making electronic health records (EHRs) more efficient and secure.²⁰ Electronic health information exchange (HIE) allows doctors, nurses, pharmacists, and other health care providers to appropriately access and securely share a patient's vital medical information electronically.²¹ Physicians and other healthcare personnel need patient records to provide timely treatment. However, without a universal health information exchange (HIE) health care providers are forced to make critical medical decisions without sufficient information, particularly emergency room physicians.

c. Data Breaches

Healthcare data breaches have become the new norm around the world, but the biggest hit has been felt here in the United States. In 2018, the Department of Health and Human Services' Office for Civil Rights (OCR) received notifications of data breaches that resulted in the exposure of 13 million total healthcare records.²² Unsurprisingly, data breaches are the highest in the United States – where the average cost for a healthcare breach in 2019 was \$429 per record – an increase from \$408 in the previous year.²³ Data breach costs increase significantly year-after-year. In the last five years, there has been a 12% increase in data breach

¹⁸ *What is HIE?*, Health Information Exchange, HealthIT.gov (May 1, 2019), <https://www.healthit.gov/topic/health-it-and-health-information-exchange-basics/what-hie>.

¹⁹ Mark A. Engelhardt, *Hitching Healthcare to the Chain: An Introduction to Blockchain Technology in the Healthcare Sector*, Technology Innovation Management Review (Oct. 2017), <https://timreview.ca/article/1111>.

²⁰ Andre Henrique Mayer, et al., *Electronic Health Records in a Blockchain: A systemic review*, Health Informatics Journal (Sep. 30, 2019), <https://journals.sagepub.com/doi/full/10.1177/1460458219866350>.

²¹ *What is HIE?*, Health Information Exchange, HealthIT.gov (May 1, 2019), <https://www.healthit.gov/topic/health-it-and-health-information-exchange-basics/what-hie>.

²² Hannah S. Chen, et al., *Blockchain in Healthcare: A Patient-Centered Model*, Biomedical Journal of Scientific & Technical research, U.S. National Library of Medicine National Institutes of Health (Aug. 8, 2019), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6764776/#R1>.

²³ *Id.*

costs.²⁴ Cybercrimes are particularly prevalent, and the effects of a data breach are felt for years, especially given the sensitive data stored in healthcare facilities. Our healthcare system needs to invest in the security of its patients and stop being the victim of data breaches.

V. In an age where accessibility is at our fingertips, current healthcare services are not accessible to all patients and some may be causing more harm than good.

a. Telehealth

Technology all around us has significantly evolved within the last decade. Everything from our phone, TV's, watches, cars, and even our homes have felt the advancement in technology. Yet, despite these advances in our society, a J.D. Power study, conducted in 2019, found that only 9.6% of Americans have used telehealth services and 74.3% say they do not have access or are unaware of telehealth options.²⁵ Telehealth is a broad scope of remote healthcare services, different from telemedicine, which refers specifically to remote clinical services.²⁶ Of course, given our current COVID-19 health crisis, it is likely that telehealth options will gain more recognition.

b. Electronic Health Records

A decade ago, electronic health record (EHR) systems were introduced with the attempt to transform the healthcare system from a mostly paper-based industry to one that would deliver higher quality of care to patients.²⁷ Today, EHR's may be causing more problems than fixes. The

²⁴ *2019 Cost of a Data Breach Study Reveals Increase in U.S. Healthcare Data Breach Costs*, HIPAA Journal (Jul 24, 2019), <https://www.hipaajournal.com/2019-cost-of-a-data-breach-study-healthcare-data-breach-costs/>.

²⁵ *One in 10 Americans Use Telehealth, But Nearly 75% Lack Awareness or Access, J.D. Power Finds* (Jul. 31, 2019), https://www.jdpower.com/sites/default/files/2019185_telehealth_usage_and_awareness.pdf.

²⁶ *What is Telehealth? How is Telehealth different from Telemedicine?* HealthIT.Gov (Mar. 1, 2020), <https://www.healthit.gov/faq/what-telehealth-how-telehealth-different-telemedicine>.

²⁷ Nir Menachemi & Taleah H. Collum, *Benefits and drawbacks of electronic health record systems*, Risk Management and Healthcare Policy (May 11, 2011), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3270933/>.

major challenge facing EHRs is interoperability, this is because most current systems are not capable of communicating with one another, which limits access to a patient's medical history.²⁸

Additionally, A study published by the Journal of the American Medical Association found that “usability of electronic health record is associated with patient harm events.”²⁹ The study looked at 1.7 million reports of safety issues and found 1,956 that mentioned a health record system as a cause of patient harm.³⁰ 557 reports had “language explicitly suggesting EHR usability contributed to possible patient harm,” and among those, eighty caused temporary harm, seven may have caused permanent harm, and two may have been fatal.³¹ Our current health care services are proving more harmful than beneficial, which should give rise to a new technology that offers higher quality of care for patients.

c. Bay Area Hospital Task Force

I had the wonderful opportunity to speak with the Privacy and Regulatory Counsel for a prominent healthcare system in the Bay Area. During our conversation she mentioned being a member of the Bay Area Hospital Task Force.³² She explained that Bay Area hospitals created a Task Force that will enhance access to healthcare services through a network of clinically integrated providers. That is, the Task Force has developed a partnership between Bay Area hospitals and physician groups to create an electronic health record (EHR) ecosystem. This ecosystem will enable the partnership to function as a clinically integrated network, even though the participating healthcare providers work for different healthcare facilities. This Task Force is only being applied to complex patients as a pilot program, with the intention of being rolled out

²⁸ Jen A. Miller, *EHRs: A Look at Their Problems and Potential*, HealthTech Insider (Nov. 18, 2019).

²⁹ Jessica L. Howe, et al., *Electronic Health Record Usability Issues and Potential Contribution to Patient Harm*, Journal of American Medical Association (Mar. 27, 2018), <https://jamanetwork.com/journals/jama/fullarticle/2676098>.

³⁰ *Id.*

³¹ *Id.*

³² Telephone Interview with Privacy and Regulatory Counsel (Mar. 24, 2020).

to the general public, if it is successful. This EHR integration between healthcare providers will improve efficiency, coordination, and patient care.

VI. Healthcare Areas that will Benefit from Blockchain

a. Interoperability

In health care, interoperability is significantly important in order to have information flow seamlessly and instantly. Proper management of healthcare data and easily accessible patient information will improve healthcare outcomes by providing holistic views of patients and allowing for timely and personalized treatments. Inefficient communication between medical professionals costs the healthcare industry a shocking \$11 billion a year.³³ Blockchain technology offers a cure to these staggering costs. With blockchain, patient data is in one decentralized ecosystem, which can quickly and efficiently be referenced by medical personnel and by the patient. Blockchain will enable the efficient sharing of healthcare data while ensuring data integrity and protecting patient privacy.

i. Blockchain use cases improving interoperability

The following blockchain systems will enable access to medical records and may soon be adopted by healthcare facilities around the world. First, “MedBlock, a blockchain based information management system, enables efficient Electronic Medical Records (EMR) access and retrieval through distributed blockchain principles.”³⁴ MedBlock will allow patients to have full and secure access to all of their records and medical history.³⁵ MedBlock is highly secured by access control and cryptography.³⁶

³³ *Top 5 Inefficiencies in Hospital Operations*, Becker’s Clinical Leadership & Infection Control (Feb. 18, 2016), <https://www.beckershospitalreview.com/quality/top-5-inefficiencies-in-hospital-operations.html>.

³⁴ Kai Fan, et al., *MedBlock: Efficient and Secure Medical Data Sharing Via Blockchain*, *Journal of Medicine Systems* (June 21, 2018).

³⁵ *Id.*

³⁶ *Id.*

Similarly, MedRec, a private blockchain system that is currently being developed at MIT, also helps with interoperability. “MedRec is designed to allow healthcare providers to securely share EHR for access to patient health records. Instead of storing all of the health records on a blockchain, it uses smart contracts to point to the location of EHR and authenticate that the person trying to reach the EHR is authorized to do so.”³⁷ These are only two of several EHRs that are currently being engineered to facilitate the access to patient data.

b. Securing patient data

Security is particularly important in the healthcare industry, especially since it is the industry with the highest breach costs.³⁸ The healthcare industry is heavily targeted for data breaches, “[b]etween 2009 and 2019 there have been 3,054 healthcare data breaches involving more than 500 records. Those breaches have resulted in the loss, theft, exposure, or impermissible disclosure of 230,954,151 healthcare records. That equates to more than 69.78% of the population of the United States. In 2019, healthcare data breaches were reported at a rate of 1.4 per day.”³⁹ These alarming statistics are a representation of our current system.

Data security is a fundamental priority in blockchain technology. A priority that will be secured through: blockchain encryption, privacy preserving keyword searches, and smart contracts.⁴⁰ In accordance with general best practices, the blockchain should not have anything stored in plain text.⁴¹ Information that is *public* or intended for all nodes within the network shall be encrypted by a network-shared key, and sensitive data should be encrypted by the originating

³⁷ Darin Soat, *Blockchain in Healthcare*, Lawrence, Evans & CO., LLC (Nov. 2018), <http://www.lawrenceevans.com/2018/11/20/blockchain-in-healthcare-whitepaper/>.

³⁸ *2019 Cost of a Data Breach Study Reveals Increase in U.S. Healthcare Data Breach Costs*, HIPAA Journal (Jul. 24, 2019), <https://www.hipaajournal.com/2019-cost-of-a-data-breach-study-healthcare-data-breach-costs/>.

³⁹ *Healthcare Data Breach Statistics*, HIPAA Journal (Mar. 3, 2020), <https://www.hipaajournal.com/healthcare-data-breach-statistics/>.

⁴⁰ Kevin Peterson, et al., *A Blockchain-Based Approach to Health Information Exchange Networks*, Mayo Clinic, HealthIT.Gov, 7 (Mar. 3, 2020), <https://www.healthit.gov/sites/default/files/12-55-blockchain-based-approach-final.pdf>.

⁴¹ *Id.*

node, if possible.⁴² If encryption is not possible, a patient’s record must be deidentified pursuant to HIPAA compliance.

Secondly, in order to “facilitate data searchability and discoverability, Privacy Preserving Keyword Searches shall be used.”⁴³ This will allow for all external entities to request transactions from the blockchain, and “both the query and the transaction [will] remain encrypted.”⁴⁴ Lastly, smart contracts are coded as computing protocols, stored inside blockchain systems, and self-executed.⁴⁵ Here, smart contracts shall be used when patients authorize access to their records. For example, “a patient may want their data shared only for research of a certain type, or for a given time range.”⁴⁶ If that is the case, a smart contract should be placed on the blockchain as a transaction, “providing not only assurance of validity but an audit mechanism as well.”⁴⁷

c. Supply chain and counterfeit drugs detection

Blockchain technology has the potential to innovate healthcare contract management by providing real-time contract tracking, execution, and ability for users to determine the satisfactory completion of contracts.⁴⁸ A blockchain-enabled supply chain can assign an identity to people, organizations, and goods. It can also manage exchanges and payments, all of which can be tracked as they pass one organization to the next.⁴⁹ Blockchain-enabled supply chains rely on smart contracts, and no third-party intermediaries, which ultimately saves money and reduces

⁴² *Id.*

⁴³ *Id.*

⁴⁴ *Id.*

⁴⁵ Yu Zhuang, et al., *Applying Blockchain Technology for Health Information Exchange and Persistent Monitoring for Clinical Trials*, AMIA Annual Symposium, Proceedings Archive (Dec. 5, 2018), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6371378/>.

⁴⁶ *Id.*

⁴⁷ *Id.*

⁴⁸ Chet Stagnaro & Freed Associates, *White Paper: Innovative Blockchain Uses in Health Care*, Freed Associates 2 (Mar. 5, 2020), https://www.freedassociates.com/wp-content/uploads/2017/08/Blockchain_White_Paper.pdf.

⁴⁹ *Id.* at 10.

mistakes.⁵⁰ By eliminating third parties and human-error, blockchain-enabled supply chains have the potential to reduce costs.⁵¹

Blockchain-enabled supply chains can also help with the growing concern surrounding counterfeit drugs. There is a need for a system to track and verify the ingredients of a drug, during each step in the supply chain. Blockchain technology would allow for tracking and tracing of the pharmaceutical supplies that pass through the supply chain. Blockchain technology provides a perfect solution for information to be maintained in a tamper-proof system accessible to multiple parties. The MediLedger Project, which started in 2017, focuses on helping the pharmaceutical industry by facilitating compliance with the Drug Supply Chain Security Act (DSCSA).⁵²

VII. Legal Implications that may Arise

a. Health Insurance Portability and Accountability Act (HIPAA)

Healthcare is one of the most privacy-sensitive data domains, which requires extensive privacy regulations. The HIPAA Privacy guidelines “require health care providers and organizations, as well as their business associates, to develop and follow procedures that ensure the confidentiality and security of protected health information (PHI) when it is transferred, received, handled, or shared.”⁵³ HIPAA applies to all forms of PHI, including paper, oral, and electronic, etc.⁵⁴ Given the decentralized distributed nature of blockchain, HIPAA concerns may develop in two ways: First, issues regarding protected health information may arise because blockchain technology enables data to be replicated to multiple nodes within a network. In order

⁵⁰ *Id.*

⁵¹ *Id.* at 2.

⁵² The MediLedger Project, Mediledger (Mar.1, 2020), <https://www.mediledger.com>.

⁵³ *Health Insurance Portability & Accountability Act*, Department of Health Care Services (June 13, 2019), <https://www.dhcs.ca.gov/formsandpubs/laws/hipaa/Pages/1.00WhatisHIPAA.aspx>.

⁵⁴ *Id.*

to avoid HIPAA violations, protected health information should be held in private blockchains, separate from transactions that are distributed and accessed by all nodes. This means that protected health information should be separated and deidentified. Additionally, smart contracts should be attached to each transaction, allowing medical personnel to access protected health information (PHI) only when consent has been retained. The second HIPAA violation may arise from blockchain's mathematically derived pseudonyms. "HIPAA prohibits the use of mathematically derived pseudonyms because of potential re-identification of de-identified protected health information (PHI)."⁵⁵ A solution to this problem would be "to combine blockchain with Dynamic Data Obscurity to support non-mathematically derived dynamically anonymous identifiers."⁵⁶ By merging blockchain and Dynamic Data Obscurity, de-identification would be in compliance with HIPAA.⁵⁷ Overall, blockchain technology can provide a way for healthcare professionals to securely store patient health information better than it is being stored today.

VIII. Conclusion

Blockchain technology is in its early stages but there is a concerted effort to move the technology forward. Like any new technology, blockchain in the healthcare industry requires adoption and development by multiple stakeholders. Stakeholders in this industry would include hospitals, healthcare personnel, device manufacturers, patients, etc. These stakeholders are vital in the adoption of blockchain because changes to the current operations would be necessary. Without full adoption by the stakeholders, the blockchain will not function to its full potential.

⁵⁵ Gary LaFever, *Blockchain and big data privacy in healthcare*, International Association of Privacy Professionals (IAPP), (May 2, 2016), <https://iapp.org/news/a/blockchain-and-big-data-privacy-in-healthcare/>.

⁵⁶ *Id.*

⁵⁷ *Id.*

Therefore, blockchain technology is the answer to greater efficiency and innovation, making it the key to facilitating our complex healthcare system.