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HEALTHCARE BLOCKCHAIN INFRASTRUCTURE:  
A COMPARATIVE APPROACH

Ana Santos Rutschman<sup>1</sup>

*Abstract*

*Blockchain has been hailed as the most disruptive technology of the next decade. One of the areas of immediate application is healthcare, where different types of blockchain applications could help streamline data sharing, protect patient privacy, and assist in the monitoring of drug shipments. This Article explores the first steps taken by healthcare companies in the United States to incorporate blockchain solutions into their business models. It then contrasts them to ongoing experiments in the European Union, with a focus on Sweden's adoption of CareChain (a national, interoperable blockchain health data platform) and Estonia's digitization of 95% of the country's health data.*

I. BLOCKCHAIN TECHNOLOGY IN HEALTHCARE

Blockchain, the technology developed in connection with cryptocurrencies<sup>2</sup> like Bitcoin, is poised to disrupt<sup>3</sup> an increasingly growing number of industries. No matter what the field, the basics of blockchain<sup>4</sup> remain the same: it is a series of transactional records kept by a network of decentralized databases. Decentralization and encryption techniques make it very difficult<sup>5</sup> to falsify information shared within the chain. This enables parties to exchange data more securely<sup>6</sup> than before and without the need for any intermediaries.

Several characteristics make blockchain especially well-suited for healthcare applications. First and foremost, it has the potential to make the sharing of health data more efficient. In a decentralized system but interoperable system, it is easier to pull scattered records from different sources. And even though there are different types of blockchains and blockchain

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<sup>2</sup> Andy Extance, *The Future of Cryptocurrencies: Bitcoin and Beyond*, <https://www.nature.com/news/the-future-of-cryptocurrencies-bitcoin-and-beyond-1.18447>

<sup>3</sup> Don Tapscott & Alex Tapscott, *The Impact of the Blockchain Goes Beyond Financial Services*, HARV. BUS. REV., <https://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services>

<sup>4</sup> Philippa Ryan, *Demystifying the Blockchain: A Basic User Guide*, The Conversation (Jul. 12, 2016), <https://theconversation.com/demystifying-the-blockchain-a-basic-user-guide-60226>

<sup>5</sup> BLOCKCHAIN COUNCIL, *Where Is Blockchain Hosted & Why It Is Difficult To Hack It?*, <https://www.blockchain-council.org/blockchain/where-is-blockchain-hosted-why-it-is-difficult-to-hack-it/>

<sup>6</sup> Michael J. Casey & Paul Vigna, *In Blockchain We Trust*, MIT TECH. REV. (Apr. 9, 2018), <https://www.technologyreview.com/s/610781/in-blockchain-we-trust/>

protocols,<sup>7</sup> the industry is taking steps towards interoperability,<sup>8</sup> so that data developed in different platforms can be easily brought together.

Blockchain can also help make health data more easily verifiable and secure. Blockchain relies on public-key cryptography:<sup>9</sup> the system issues a pair of keys (simply put, large numbers), one of which is kept secret (the private key), while the other is shared among agents in a chain (the public key). The keys operate as digital signatures, which are used to encrypt and decrypt data. Transactions are recorded in a way that is verifiable by all parties involved, which means that records should become more accurate, even when pooled from different sources.

In the US, we are now seeing major players in the healthcare industry jumping on the blockchain bandwagon.

## II. THE MANY FACETS OF HEALTHCARE BLOCKCHAIN

Healthcare blockchains can be deployed to lower transaction costs of data sharing, improve accuracy of records, make transactions faster and more secure, and strengthen the privacy of patients.

Applying blockchain to medical recordkeeping and record exchange illustrates all of these aspects. Electronic health records<sup>10</sup>, digital files of a patient's medical chart, have long been produced in scattered, siloed ways. For instance, in Boston alone, there are over two dozen different systems<sup>11</sup> operating electronic health records, none of which is interoperable. This makes medical recordkeeping inefficient and renders data sharing between institutions (or even within a single institution) extremely hard. Studies have shown that, in some cases, flaws in electronic recordkeeping may result in direct harm to patients.<sup>12</sup>

Cue in blockchain: even with medical records spread between different providers or institutions, a doctor added to a chain of electronic health records will immediately be able to access, correct or add to the entire medical history of a patient—at least from the moment it is recorded on the chain—and the doctor's actions can be verified by the other members of the

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<sup>7</sup> MEDIUM, *Top 5 DLT Blockchain Protocols to Consider in Your Project*, <https://medium.com/swlh/top-5-dlt-blockchain-protocols-to-consider-in-your-project-dae7fc6d381d>

<sup>8</sup> Andrew Deichler, *Interoperability: The Holy Grail of Blockchain*, AFP Online (Oct. 25, 2017), <https://www.afponline.org/trends-topics/topics/articles/Details/interoperability-the-holy-grail-of-blockchain>

<sup>9</sup> Charles C. Mann, *A Primer on Public-key Encryption*, THE ATLANTIC (Sept. 2002), <https://www.theatlantic.com/magazine/archive/2002/09/a-primer-on-public-key-encryption/302574/>

<sup>10</sup> CENTERS FOR MEDICARE AND MEDICAID SERVICES, *ELECTRONIC HEALTH RECORDS*, <https://www.cms.gov/Medicare/E-Health/EHealthRecords/index.html>

<sup>11</sup> Mike Orcutt, *Who Will Build the Health-Care Blockchain?*, MIT TECH. REV. (Sept. 15, 2017), <https://www.technologyreview.com/s/608821/who-will-build-the-health-care-blockchain/>

<sup>12</sup> Jessica L. Howe et al., *Electronic Health Record Usability Issues and Potential Contribution to Patient Harm*, 319 JAMA 1276, <https://jamanetwork.com/journals/jama/article-abstract/2676098>

chain. These include patients given access to the chain, who would then be able to monitor the ledger containing all entries. When appropriate, patients themselves would be able to contribute or supplement information, and even to dispute or help eliminate inaccurate information.

The same model can be applied to other areas in healthcare. Take the case of supply chains: pharmaceutical companies currently monitor drug shipments and delivery through scattered databases that are not particularly efficient;<sup>13</sup> with blockchain, that process would become more comprehensive and much harder to hack. This is essentially the strategy that Walmart has been developing<sup>14</sup> for the past two years in order to improve monitoring of its food supply chain. In 2017, Pfizer and other pharmaceutical companies backed MediLedger,<sup>15</sup> the first major project in the US to develop blockchain technology specifically for pharmaceutical supply chains.

Clinical trials, too, may benefit from blockchain. Today, patchy data and inefficient communication between all players involved in clinical trials pose serious problems.<sup>16</sup> With comprehensive data aggregation made possible by blockchain, not only would there be better data<sup>17</sup> available to all parties, but also better chains of communication between all these players. Similar benefits are likely to extend to the drug discovery and development process as well.

On a different front, blockchain can be used to enhance public health: the Centers for Disease Control and Prevention<sup>18</sup> are developing new blockchain-based technologies to share data on threatening pathogens, analyze outbreaks and manage the response to public health crises. Some commentators have even suggested that blockchain might be a useful tool in fighting the opioid crisis.<sup>19</sup>

### III. BUILDING THE HEALTHCARE BLOCKCHAIN INFRASTRUCTURE: THE US TAKES FIRST STEPS

While promising, healthcare blockchain lacks a supporting infrastructure. But things appear to be changing, at least within some segments of the industry. Early in 2018, a consortium

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<sup>13</sup> Jeff John Roberts, *Big Pharma Turns to Blockchain to Track Meds*, FORTUNE (Sept. 27, 2017), <http://fortune.com/2017/09/21/pharma-blockchain/>

<sup>14</sup> Jessica McKenzie, *Why Blockchain Won't Fix Food Safety—Yet*, THE NEW FOOD ECONOMY ONLINE (Feb. 4, 2018), <https://newfoodeconomy.org/blockchain-food-traceability-walmart-ibm/>

<sup>15</sup> Jeremy Nation, *Pfizer and Genentech Turn To Ethereum Blockchain*, ETH NEWS (Oct. 2, 2017), <https://www.ethnews.com/pfizer-and-genentech-turn-to-ethereum-blockchain>

<sup>16</sup> Andrew Nusca, *Here's the Problem with Today's Human Clinical Trials*, FORTUNE (Mar. 20, 2018), <http://fortune.com/2018/03/20/human-clinical-trials/>

<sup>17</sup> Mehdi Bouchoufi & Philippe Ravaud, *Blockchain Technology for Improving Clinical Research Quality*, 18 TRIALS 335 (Jul. 19, 2017), <https://trialsjournal.biomedcentral.com/articles/10.1186/s13063-017-2035-z>

<sup>18</sup> Brian Lee, *CDC Health Information Innovation Consortium February Forum* (Feb. 20, 2018), available at [https://www.cdc.gov/ophss/chiic/forums/CDC-Blockchain-Overview\\_-v16\\_tgs\\_2\\_2018-508.pdf](https://www.cdc.gov/ophss/chiic/forums/CDC-Blockchain-Overview_-v16_tgs_2_2018-508.pdf)

<sup>19</sup> Mike Orcutt, *Why the CDC Wants in on Blockchain*, MIT TECH. REV. (Oct. 2, 2017), <https://www.technologyreview.com/s/608959/why-the-cdc-wants-in-on-blockchain/>

of five healthcare organizations launched a pilot project to apply blockchain technology to healthcare provider data<sup>20</sup> as a way to fix current problems with provider lists. The project is set to be completed in the fall.<sup>21</sup>

An important feature of this particular project is the identity of the parties involved: UnitedHealthcare, Optum, Humana, Quest Diagnostics and MultiPlan. These are not small players. Both UnitedHealthcare and Optum are part of UnitedHealthcare Group, the largest health insurance company in the US, currently ranked 5<sup>th</sup> on the Fortune 500 list<sup>22</sup> Humana is the fifth largest American insurer. Quest Diagnostics is a national medical lab used by roughly a third of adult Americans.<sup>23</sup> And MultiPlan processes insurance claims for large health insurance companies, having a network of over 900,000 healthcare providers.<sup>24</sup>

The heft of this alliance, and especially the fact that it includes direct competitors like United and Humana, indicates a shift from ad hoc initiatives to industry-wide approaches to the development of healthcare blockchain. Similar alliances are now needed in other domains to ensure the creation of a national infrastructure—or different types of infrastructures—for healthcare blockchain.

#### IV. HEALTHCARE BLOCKCHAIN ABROAD: EUROPE TAKES THE LEAD

While in the US the creation of an infrastructure seems more dependent on private actors, the European Union has taken the lead in pioneering transnational approaches to healthcare blockchain. Since 2016, it has funded MyHealthMyData,<sup>25</sup> a platform that uses blockchain technology to aggregate and share biomedical information between healthcare organizations and individual patients. Among other things, this includes the creation of personal health data storage accounts in the cloud, which will be accessible from any type of electronic device.

An important feature of this model is that, although the European Union is conceptualizing and spearheading the creation of blockchain infrastructure for health data, it does so under a consortium model. Partners include entities like Siemens and leading research universities.<sup>26</sup> This should be of notice to policymakers in the US, as it might indicate that diversified partnerships are a better way of building health blockchain infrastructure.

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<sup>20</sup> Rachel Z. Arndt, *Humana, Optum, Others Team Up for Blockchain-Enabled Data-Sharing*, MODERN HEALTHCARE (Apr. 2, 2018), <http://www.modernhealthcare.com/article/20180402/NEWS/180409999>

<sup>21</sup> Bertha Coombs, *Insurers Will Study Blockchain to Fix Their Provider Lists*, CNBC Online (Apr. 2, 2018), <https://www.cnbc.com/2018/04/02/insurers-will-study-blockchain-to-fix-their-provider-lists.html>

<sup>22</sup> FORTUNE 500, available at <http://fortune.com/fortune500/list/>

<sup>23</sup> QUEST DIAGNOSTICS, FACT SHEET, <http://newsroom.questdiagnostics.com/index.php?s=30664>

<sup>24</sup> Greg Roumeliotis, *Greenberg's Starr Leads \$4.4 Billion Multiplan Acquisition*, REUTERS (Feb. 17, 2014), <https://www.reuters.com/article/us-starrinvestment-acquisition-multiplan-idUSBREA1G0P620140218>

<sup>25</sup> MYHEALTHMYDATA, available at <http://www.myhealthmydata.eu>

<sup>26</sup> MYHEALTHMYDATA, CONSORTIUM, available at <http://www.myhealthmydata.eu/consortium/>

The consortium model has also been adopted in the European Union at the national level. In 2017, Sweden began rolling out CareChain,<sup>27</sup> an interoperable blockchain health data platform deliberately framed as “infrastructure that is owned and controlled by no one and everyone.” CareChain is in charge of the design and development of the platform, but the expectation is that different entities will be able to contribute add-on capabilities to the network in the near future. Already a broad and diverse range of institutions are part of the consortium, advising CareChain along the way. For example, the consortium<sup>28</sup> includes hospitals, pharmacies, health insurance companies, academia, the government, pharmaceutical companies, financial technology companies, startups and network operators.

An early adopter of technology crucial to the establishment of a national blockchain infrastructure was Estonia. Since 2012, Estonia has been using blockchain technology to secure health care data and transactions,<sup>29</sup> including putting 95% of health data in electronic form.<sup>30</sup> All of the country’s health care billing is handled electronically, and 99% of its prescriptions are digital.<sup>31</sup>

## CONCLUSION

As the US begins looking into the future of healthcare blockchain, taking a cue from large-scope projects already underway would be a good idea. They are natural experiments in infrastructure development, and they afford instrumental cues on stakeholder participation, as well as blockchain design and management in the health arena.

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<sup>27</sup> CARECHAIN, A JOINT EFFORT TO ESTABLISH BLOCKCHAIN INFRASTRUCTURE AND PERSONAL DATA MANAGEMENT FOR HEALTH, available at <https://www.carechain.io/#page-top>

<sup>28</sup> CARECHAIN, MEMBERS, available at <https://www.carechain.io/#members>

<sup>29</sup> E-ESTONIA, WE HAVE BUILT A DIGITAL SOCIETY AND SO CAN YOU, available at <https://e-estonia.com>

<sup>30</sup> E-ESTONIA, HEALTHCARE, available at <https://e-estonia.com/solutions/healthcare/e-health-record/>

<sup>31</sup> E-ESTONIA, HEALTHCARE, available <https://e-estonia.com/solutions/healthcare/e-prescription/>