

# Blockchain in Healthcare



*Source: Panchenko Vladimir, Shutterstock.com*

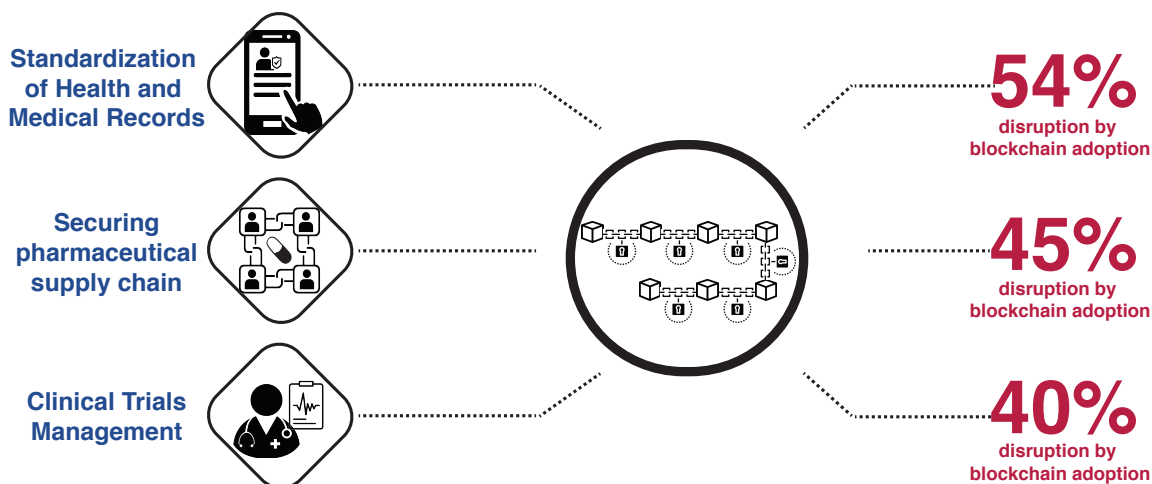
## **BLOCKCHAIN: the magic pill to alleviate the pain points of the healthcare industry?**

**Richa Sharma, PhD**  
**FCCCO**

# TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>3</b>
<b>INTRODUCTION .....</b>	<b>4</b>
<b>THE CASE FOR BLOCKCHAIN IN HEALTHCARE.....</b>	<b>10</b>
<b>CAN BLOCKCHAIN CURE THE PAIN POINTS OF HEALTHCARE.....</b>	<b>16</b>
<b>CHALLENGES TO BLOCKCHAIN ADOPTION IN HEALTHCARE .....</b>	<b>20</b>
<b>CONCLUDING REMARKS .....</b>	<b>23</b>
<b>REFERENCES .....</b>	<b>25</b>

## EXECUTIVE SUMMARY



Over the recent years, the increasing costs of healthcare and unsustainable architecture of the industry have put tremendous pressure on the world economies. The regulatory bodies have recognized interoperability, drug traceability, and data security as the most urgent issues in the healthcare industry.

In this paper, we discuss the evolution of blockchain, its implications in healthcare and possible hurdles to adoption. We have focussed on three main areas of healthcare that seem to require the most imminent attention. These include standardization of health and medical record, securing the pharmaceutical supply chain and management of clinical trials. Adoption of blockchain based innovative solutions could disrupt the current roadblock in these areas by approximately 50% by 2023. It is predicted that neither AI nor big data analytics or CRISPR will have as much of a ground-breaking impact as Blockchain in revolutionizing the healthcare industry.

## INTRODUCTION

Blockchain was originally developed in 2008 as the underlying technology allowing peer-to-peer transactions of cryptocurrencies such as Bitcoin. Just as the world was recovering from the economic crisis of 2008, this new cryptocurrency arrived with the promise of solving the problem of double spending through the use of blockchain. The idea of cryptographic time-stamp for securing digital data into a network of blocks was initially proposed by Stuart Haber and W. Scott Stornetta in 1991. It was, however first implemented for setting up a blockchain for transactions of Bitcoin in 2009 by the inventor(s) under the pseudonym, Satoshi Nakamoto.

This peer-to-peer (P2P) decentralized network allowed transactions without reliance on third-party trust or validation. In 2015, *The Economist* article dubbed the technology of blockchain as ‘the trust machine’ that could transform the way the world economies work. While it may seem to be a complex technology, the idea behind blockchain is simple and elegant. Blockchain in its most simplified form is an incorruptible distributed digital ledger or database allowing peer-to-peer direct transactions ranging from money, financial assets such as stocks and bonds, intellectual property, music, art, data, contracts and even votes. The trust in blockchain is not established through banks, governments or third-party intermediaries but through a systematic network consensus, collaboration, and cryptography. The blocks of data are securely recorded and are continuously

updated as new transactions are made. This list is shared by all parties participating in the transaction through a distributed network of computers.

The term 'digital economy' was first coined in the early 90's by Don Tapscott in his book, *The Digital Economy: Promise and Peril in the Age of Networked Intelligence*, which discussed how the internet would change the way we conduct business. The world wide web revolution in early to mid-90's through the use of TCP/IP (transmission control protocol/internet protocol) technology brought the democratization of information. The TCP/IP model was based on an open, publicly shared network without any centralized authority/control. The exploits of internet technology gave birth to new businesses, reshaped the world economies and dramatically lowered the cost of connectivity and information. However, it wasn't able to completely transform e-commerce, as it still relied on banks and trusted governing institutions for validating and processing payments and transactions. Even though today globally financial institutions move trillions of dollars via the internet, some of the operational procedures remain antiquated and time-consuming. This has caused problems such as high transaction fees and costs, operational delays as well as frauds. The advent of disruptive technologies such as Blockchain has allowed us to rethink how we could simplify and regulate the current model of the financial industry and decrease its susceptibility to cyber crimes. The fact the blockchain can be an added layer to the internet providing not only information but a value to every process, transaction, payment, contract and task through a digital footprint that can be

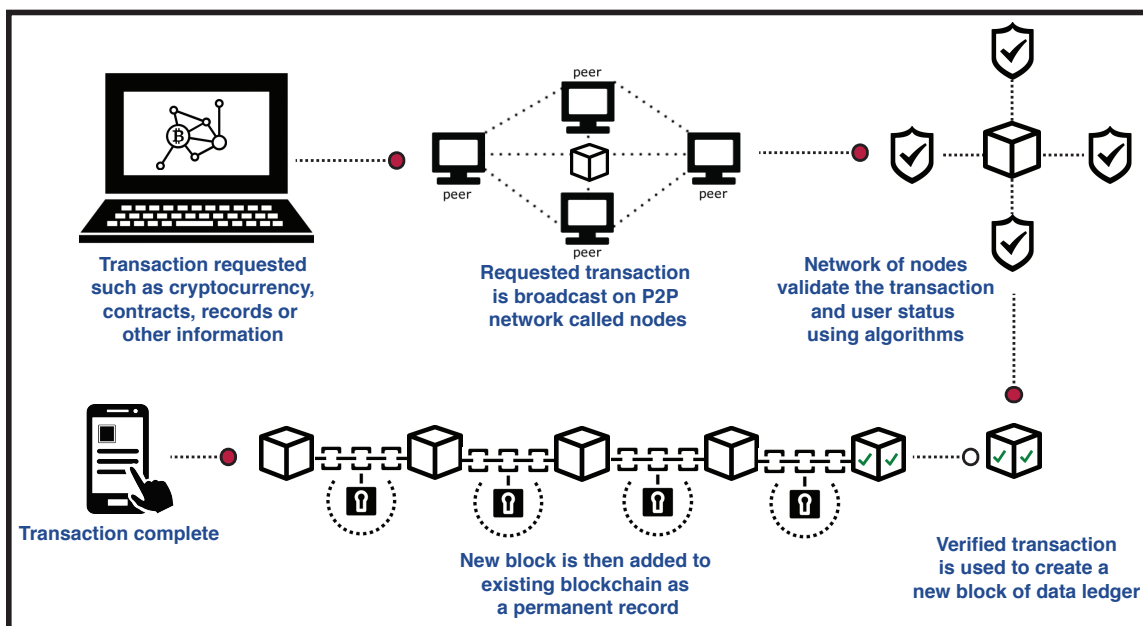
identified, validated, recorded and transmitted to organizations, computers, and even unknown individuals without any fear or friction. This immense potential of blockchain has garnered the attention of not only the financial and banking industry but also has sparked interests of various public and private sector industries such as government and regulatory bodies, insurance, security, trade, IoTs, healthcare and pharmaceuticals, academia, sports and entertainment industries to name a few.

## **What is blockchain and how does it work?**

Blockchain can be defined as a digitized, decentralized public ledger of transactions. Every transaction is collectively stored in a unit of data called a block which is linked securely to the previous record thus forming a chain of information, that can be accessed by a group of users on the blockchain.

The principles of blockchain allow us to better understand its underlying architecture that makes blockchain not only a disruptive technology but more so a transformative foundational technology with profound impact. Firstly, it is a distributed database that allows every party on the blockchain to access its entire history and information. No single entity or centralized system owns the data, rather trust is encoded in the blockchain protocol and is maintained by the community of users. Every party can verify the transaction records without the need of an intermediary. The second point is that it relies on peer-to-peer (P2P) communication through nodes on the blockchain network. Each node stores and

broadcasts cryptographically secured digital signatures and information to other nodes on the blockchain network during a transaction.



Source: Modified from PWC infographic- A primer on blockchain

Blockchain is designed as a transparent medium that maintains pseudonymity. Users on blockchain have the option of remaining anonymous and have a unique 30-digit address or public key which is sufficient for the purpose of transactions. Every transaction and its associated value is visible to all the users with access to a particular process, providing transparency to this process. Every transaction is linked to its previous history and cannot be deleted or removed. Computational algorithms are deployed to ensure that any alteration becomes a permanent chronological record that is updated across all the nodes. Some of the advantages of this revolutionary technology are increased transparency, precise

traceability, accurate record-keeping, data safety and privacy and reduced costs of transactions. Few of the disadvantages of this pioneering technology that could disrupt existing mechanisms of business could be barriers to adoption and implementation, the initial cost of set-up, its regulatory compliance and future technological competitors.

## **Application of blockchain across industries**

Given its roots in digital economy and cryptocurrencies, it should not be any surprise that the earliest adopters of Blockchain have been major financial institutions and banking industry. European banks UBS and Barclays have started to experiment with blockchain as a technological advancement that could improve and expedite operations, data management, and settlements, potentially saving up to \$20B in costs. Major banking giants have invested in the blockchain R&D startups like R3 CEV to develop a blockchain platform Corda, to harness the power of the technology and establish a new operating system for financial markets. Royal Bank of Canada has filed patents in the US for developing blockchain-based credit records and scoring platform as well as block-chain based financial analysis and forecasting systems.

Besides banking industry, one of the other applications of blockchain has been in the development of a decentralized network for IoTs devices and sensors that could mediate record-keeping and software and web-security. IBM and Samsung have collaborated on this proof-of-concept called ADEPT (“Autonomous Decentralized Peer-to-Peer Telemetry”). In terms of public sector, blockchain



could improve data management, reduce fraud, increase transparency and accountability. Estonia has been one of the trailblazer nations in adopting and implementing hash-linked time stamping in various public sector registries such as national health, judicial, legislative and security systems. Another European nation, Georgia has been working with blockchain company BitFury Group to secure government data and records. In the US, Delaware, Illinois, and Vermont have launched an initiative to develop the infrastructure for a blockchain-based platform for various public services.

Another very critical and far-reaching application of blockchain is cyber-security. As recent as May 2018, Canadian banks such as BMO and CIBC's Fintech Simpli Financial have had data-breaches with reportedly more than 50,000 customers information being compromised. Blockchain could combat threats to cybersecurity by employing tamper-proof ledgers and advanced cryptographic techniques to ensure a more robust integral network. The age of internet 2.0 has seen the exploitation of user information for economic benefits. The big question today is how do we manage, regulate and control the use of information? The year 2018 has seen some of the biggest privacy and data infringement controversies by companies such as Cambridge Analytica misusing data of Facebook users for US Election purposes, violating the rights and privacy of millions of users.

This controversy begs us to ask the question if we are legally compliant to deal data privacy in the age of technological advancement. 25th May 2018 saw the

dawn of a new era in terms of consumer data privacy. Under the enforcement of General Data Protection Regulation (GDPR), individuals will have more control over their personal data and will be better informed about their rights and security. Blockchain could help build a universally secure platform based on pseudonymization and encryption of user data. Under the laws of GDPR, data can be only processed if consent is given by the user. GDPR is likely to become the de facto standard for global data privacy. In US and Canada, there is a need to evaluate the national data strategy that regulates companies that have access to massive amounts of user-data on how they ethically draw insights and analytics while still empowering the users. In case of healthcare, this could be especially crucial given the sensitive nature of the user information.

## **THE CASE FOR BLOCKCHAIN IN HEALTHCARE**

Among the industries that run on large-scale data analytics, healthcare and pharmaceutical industry hold the leading position. Healthcare data is complex and has a lot of players that need to coordinate, which makes transactions slow, cumbersome and expensive. Data privacy is a critical issue for healthcare and constraints to access can have major impediments to progress in research for disease cure and patient care.

Since healthcare and life sciences institutions operate on over-whelming amounts of patient data it is imminent to educate and inform patients as to how their data can facilitate the health outcomes process. Better collaboration, faster

access, and increased transparency can considerably improve patient experience as well as decrease cost of care.

Many industry experts and analysts indicate blockchain could be the possible solution to solve some of the biggest challenges and add value to the field of healthcare. In a white paper report by IBM- ‘Healthcare Rallies for Blockchain’, a study comprising of 200 payer and provider executives from 16 countries concluded that 16% of them were likely to implement commercial blockchain by 2017 and as many as 56% had plans to adopt it by 2020. The prediction is that implementation of blockchain can bring new capabilities and potentially disrupt current processes to accelerate R&D, improve care delivery and management, boost market expansion and ultimately reduce costs. The establishment of blockchain platforms could permit hospitals, payers, and other parties in the healthcare value chain to have access to patient information without compromising data security and integrity. Estonian healthcare system has been a model for blockchain-based revolution. In their healthcare system, patient data is securely recorded in an e-health record on a blockchain based platform provided by Guardtime that can be tracked, conveniently accessed and audited by patients, doctors, hospitals, and government. This robust health management system will safeguard patient data records against potential cyber-attacks. Blockchain could also be used to track and manage consent and information between patients, physicians, pharmaceutical companies and payers in managing clinical studies. In clinical trials, data management and reproducibility

are critical for patient privacy and often serve as the biggest challenges for hospitals and pharmaceutical companies. French public hospitals, Assistance Publique – Hôpitaux de Paris (AP-HP) and French national research institute for health and medical research, Inserm play a prominent role in regulating healthcare in France. Recently, these public bodies explored the use of blockchain for collection and maintenance of patients' consent information for clinical trials. They established that blockchain would enable them to have a tight security and control of the parameters to share sensitive patient information thus significantly reducing the processing times in a clinical trial. Also on the same lines, IBM Watson Health and the Food and Drug Administration (FDA) are collaborating on a research initiative to define an efficient, secure and scalable data exchange platform using blockchain. This joint venture is exploring the exchange of owner-mediated data from sources, such as electronic medical records (EMRs), clinical trials, genomic data, and health data from cellular, wearable and IoT's devices. The initial focus is to build an oncology-related database. Several blockchain startups have seen opportunities in the continuum of healthcare. California based Gem is using Ethereum blockchain-enabled technology to create a secure, universal data-sharing infrastructure in partnerships with Philips Healthcare to manage various aspects of health continuum such as claims and reimbursements, wearable technology and employee wellness programs. Also, Gem has teamed up with Centre for Disease Control (CDC) to manage population health and disaster response by building a

system for data collection and operational analysis on the blockchain. Since various proof-of-usage initiatives are proving to be successful models of applications in healthcare continuum, it begs us to ask the question as to how this foundational technology could be universally adopted and made a norm for healthcare management and pharmaceutical industry? For a complete overview of its different applications, we present an in-depth analysis into the current healthcare landscape and which areas of healthcare are most likely to first implement blockchain technology.

## Current state of healthcare industry today



*Source: Modified from HP Enterprise Services*

The Healthcare, Pharmaceutical and medical industry consists of public and private sector organizations, hospitals and physicians, governmental regulatory

bodies, companies, non-governmental organizations, insurance providers and healthcare information and management professionals. Overall, healthcare industry guides and tracks patients over time through a comprehensive array of health and medical services, manufacture medical equipments and pharmaceuticals, provide medical insurance as well as develop clinical trials and R&D. Healthcare industry is easily one of the largest growing industries accounting for more than 10% gross domestic product (GDP) of most developed countries worldwide. Not surprisingly, burden of healthcare can have enormous impact on the economy of the nation. According to OECD, the U.S. is one of the highest per capita healthcare spending nations compared to other developed nations. The U.S. healthcare system is different from most industrialized nations as it does not have a universal health care coverage, making the cost of care prohibitively high. While the U.S. has some of the highest trained and specialized healthcare professionals and physicians as well as state-of-the-art medical technologies and drugs, the exorbitant administrative, operational and management costs make its healthcare system highly unsustainable. With the uncertainty surrounding the Affordable Care Act (ACA) and new healthcare legislation, the focus will be on how organizations can reduce the inflated delivery costs while improving the value of care. By contrast, Canada Health Act (CHA) established a publicly funded health care system called Medicare, which ensures universal access to health care services, highly skilled health care professionals, and research institutions. The healthcare system in Canada has been largely

unchanged over the last few decades and comes with its own problems and challenges. The U.S. based Commonwealth Fund, a reputable non-partisan organization states that the limited availability of comprehensive health information systems, long wait times for healthcare diagnostics and treatments, and inefficient management systems impede the quality of health outcomes and access in Canada. A sustainable healthcare system relies on ease of access, structured health information system and the ability to transform health data into knowledge that can be used to achieve affordable and effective health outcomes. The electronic exchange of health information between physicians, patients, community stakeholders and payers can facilitate the availability of the optimal healthcare product/service to the right person at the right place and time, thus improving value and the quality of health outcomes. Today, health information is stored on hospital or individual databases or on health information exchange. The sharing of records and knowledge distribution between physicians, payers and stakeholders is still a cumbersome process. Often, health information and records are riddled with problems such as lack of standards for patient data records, operational errors, trust concerns and security threats. Third-party intermediaries and health record exchanges established to confer trust in data become bottlenecks and significantly add to incurred costs and delays.

## **CAN BLOCKCHAIN CURE THE PAIN POINTS OF HEALTHCARE**

Case studies conducted by consulting and technology firms such as BCG, Deloitte, and IBM have identified and summarized some of the pain points in the healthcare industry. Of those the three most critical areas of healthcare discussed in this paper include standardization of medical/health records, securing the pharmaceutical supply chain and clinical trials management. We will delve into how blockchain could be implemented to alleviate some of the problems of the healthcare industry and its feasibility in the future.

### **- Standardization of Health/Medical Records**

Electronic health records or EHRs were first implemented in 1970's for billing purposes and have generally not been majorly updated since then. While being an important tool for physicians to track patient's medical histories, prescription records, and past test results, the lack of standard health record parameters, interoperability and security threats can make EHR management an arduous process. Blockchain-based platforms can be used to consolidate patient information from various sources such as doctors, providers, payers, medical devices, health information exchange (HIE), or other persons or entities that have had access to patient data, creating a complete digital profile for every patient. These newly integrated patient records can be visualized through easy to follow,



informative and standardized portals or apps for better diagnosis and treatment, improved traceability and security and higher quality of health outcomes. This can create an audited trail of patient's data throughout their life, which can be in control of the patient and can enable early diagnosis and preventative care. Decentralized and permission-based blockchain platforms will also help combat privacy breaches and ethical dilemmas in sharing sensitive patient data. MIT has developed a decentralized record network called MedRec for managing electronic health/medical records while maintaining accountability and confidentiality. Additionally, Google's DeepMind initiative is collaborating with U.K.'s National Health Service (NHS) to build a private platform for secure tracking of patient's health data. Also, Swiss-based Healthbank is consolidating patient-generated health data through wearable tech's and IoTs to their medical records, such that it can be used for preventative reasons. While consolidating patient data whether from EHR's or from wearable technologies might seem all-round beneficial plan, one thing to be wary of would be the quality and accuracy of the data. Organizations using blockchain platforms will potentially need to invest in building new protocols and algorithms to control the quality and authenticity of this critical information that could potentially improve and save patient lives.

## **- Securing the pharmaceutical supply chain**

The supply chain in the pharmaceutical industry is complex and can play a crucial role in maintaining the speed of delivery, quality, and safety standards, thus increasing revenues and driving profitability for big pharma. Products such as research materials, drugs, medical devices are transferred along the chain through many stakeholders such as suppliers, manufacturers, distributors, re-packagers, and retailers. This makes it important to have strict checks and regulations to track every single medically related product's authenticity and integrity from the beginning of the chain to the end at the level of the consumer. One of the most serious and threatening problems for pharmaceutical supply chains is the distribution of counterfeit and sub-standard drug products that can, more importantly, cause serious harm to patients' safety as well as incur heavy losses for big pharmas. In 2013, Drug Supply Chain Security Act (DSCSA) implemented by the FDA called for end-to-end traceability of all pharmaceutical products by 2023. According to DSCSA, the players in drug supply chain must provide transaction information, history and statement to every end-user or consumer. This triad of standards is referred to as the 'T3 information', which requires national drug code and propriety name, dosage information, batch and lot number, date of manufacturing, transaction and expiry, name and information of the dispenser as well as end-user. This could be achieved through the integration of blockchain technology to maintain detailed records of the unalterable ledger which could be audited for regulatory compliance and product

integrity. Pharma giants like Genentech, Pfizer and Sanofi have invested in the MediLedger project which is a pilot program that uses blockchain tools to track medicines. Innovative companies like Modum.io combines blockchain with sensors that track environmental conditions of temperature-sensitive pharma products during shipment. Data recorded is checked against the smart contract which validates that the product meets all of the standards set out by the sender. Upon receiving the pharma product the patients can trigger notifications to sender and also release payment all on the blockchain-enabled platform. Blockchain can also transform the delivery of a prescription drug by removing barriers to entry and streamlining the delivery process. This can lower cost of prescriptions, provide better access while maintaining patient confidentiality and security.

## **- Clinical Trials Management**

Of the major pain points of the healthcare industry, the length and cost of clinical trials make it one of the most relevant cases for data integration and traceability. Currently, most clinical data exists in fragmented propriety silos, with limited interoperability and transferability. This makes clinical trials a complex process often with long periods of time dedicated to locating, integrating and validating data for recruiting patients. Pharma companies often hire third-party research investigators and vendors to coordinate and collaborate with key opinion leaders, physicians and advocacy groups for patient enrolment in different phases of clinical study. The inviolability, historicity, and transparency of decentralized

blockchain platform, makes an excellent case for adoption of this technology for clinical research and patient recruitment. Using smart contracts can allow patients, clinical trial managers, stakeholders and key opinion leaders to have a high degree of control, autonomy, and trust in the data as well as in the authenticity of the clinical trials.

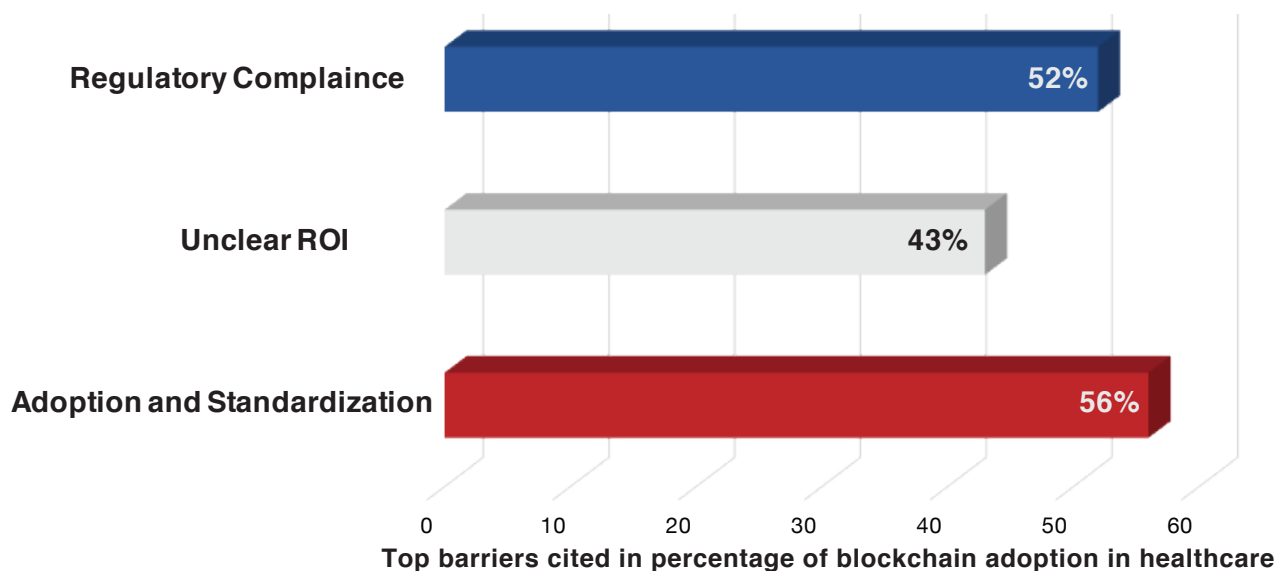
Smart contracts can be executed in a clinical trial blockchain through cryptographic hash chains and allow participation and consent of patients. Permission-based blockchains that grant access to the key groups of people in a clinical trial could record and verify novel protocols of the trial in real-time without releasing information to competitors. Once clinical data is recorded on blockchain based ledgers it could also be merged with patient outcomes to track the long-term effects of drugs and treatments on the patient population. This could make the process of data mining in clinical trials efficient, safe and sustainable for future drug development.

## **CHALLENGES TO BLOCKCHAIN ADOPTION IN HEALTHCARE**

While in theory, Blockchain is being touted as the panacea for a lot of issues in the healthcare industry and maybe ‘the foundational technology’ that will set the new norms of the future, it comes with its own set of drawbacks and barriers to adoption. While 16% of healthcare companies have been the trailblazers in the adoption of blockchain, the rest are mass adopters who have chosen to wait and

use the learning curve of the pioneers. The companies that have started to engage with blockchain, have built initial capabilities and have obtained real-world evidence towards some of the various applications might be at the most advantage of future success and profitability.

Some of the major barriers that cause reservation among the healthcare companies to adopt this technology at a faster rate are the unknown fate of regulatory compliance, unclear initial costs for the adoption of blockchain and its ROI and lack of incentives for mass adoption and standardization.



*Source: Modified from IBM Whitepaper: Healthcare rallies for blockchain*

## - Unknown fate of Regulatory compliance

Although the advantages of using blockchain platform for integrating patient data and protected health information are endless in terms of convenience, traceability

and patient consent, it could have certain problems on the regulatory aspects. The Health Insurance Portability and Accountability Act of 1996, regulated by Department of Health and Human Services (HHS) Office for Civil Rights (OCR) in the U.S., mandates a strict standard for sharing of patient's sensitive and protected health information. The users who have been granted permission on EHR blockchain networks should follow privacy policies and security standards set by HIPAA. As with any disruptive technology, the formal guidance and the regulations for blockchain in managing health information have not been defined and will need some time to be implemented by regulatory bodies as the technology continues to be tested and developed

## **- Unclear initial costs for adoption and its ROI**

One of the burning questions for mass adopters of blockchain in healthcare is: Who is taking the lead in building a universal platform for healthcare and pharmaceutical industry? Currently, the big pharmaceutical companies such as Roche, Pfizer, Sanofi, Amgen and Johnson and Johnson are all investing in collaboration with blockchain think tanks and research centers such as IBM Watson Health as well as tech start-ups to develop blockchain platforms for their organization. Also, The Hyperledger Healthcare (HLHC) Working Group, which includes Accenture, Gem, Hashed Health, IBM and Kaiser Permanente are collaborating on establishing registries and identities for health information and clinical trials pipeline. However, the mass adopters don't have means to make the

initial investment and remain wary of the long-term profitability of blockchain technology. Being a new technology, costs of establishing and running these networks is still unclear. The prediction is that since it is a decentralized system that doesn't require constant monitoring, configuration, and administration, it will be an economical and sustainable platform that will add value chain to different aspects of healthcare.

## **- Adoption and Standardization**

Standardization of technical procedures on blockchain platforms in healthcare is cited to be the highest barrier to adoption by companies. In spite of the early success of proof-of-concept work by pioneers of blockchain in healthcare, the lack of technical standards makes adoption problematic. Projects like Hyperledger can help set initial standards involving codes for procedures or services rendered, though the ideal situation would be to build a consortium with an updated regulatory compliance.

## **CONCLUDING REMARKS**

While blockchain is being prescribed as the 'magic pill' to cure interoperability, traceability and security-related issues in the healthcare industry, it won't alleviate all the problems overnight. Like any foundational technology, blockchain will need to overcome hurdles such as funding, technology and talent, governance, and collaboration, before it can become the innovation engine across all platforms of

healthcare to add value and impact. By 2025, the prediction is the adoption of blockchain for consolidating health information exchange (HIE) could save \$1.89B, pharmaceutical supply chain sector could save approximately \$100-150B and clinical trials could be made more efficient by saving \$45B annually. Besides monetary advantages, this technology will also make companies more socially responsible and sustainable, bringing back the trust of the users in data use and integration.



## REFERENCES

1. Satoshi Nakamoto. Bitcoin: A peer-to-peer electronic cash system. Consulted, 1:2012, 2008
2. S. Haber, W.S. Stornetta, "How to time-stamp a digital document," In Journal of Cryptology, vol 3, no 2, pages 99-111, 1991
3. Mougayar, William. "Understanding the Blockchain." *O'Reilly Radar*, 16 Jan. 2015, [radar.oreilly.com/2015/01/understanding-the-blockchain.html](http://radar.oreilly.com/2015/01/understanding-the-blockchain.html).
4. Tapscott, Don Tapscott Alex. "The Impact of the Blockchain Goes Beyond Financial Services." *Harvard Business Review*, 17 Feb. 2017, [hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services](http://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services).
5. "Blockchain : A Healthcare Industry View." *Capgemini Worldwide*, 20 July 2017, [www.capgemini.com/resources/blockchain-a-healthcare-industry-view/](http://www.capgemini.com/resources/blockchain-a-healthcare-industry-view/).
6. "Blockchain in Healthcare: IBM Blockchain Blog." *IBM Cognitive Advantage Reports*, IBM Corporation, 29 May 2018, [www.ibm.com/blogs/blockchain/category/blockchain-in-healthcare/](http://www.ibm.com/blogs/blockchain/category/blockchain-in-healthcare/).
7. "A Prescription for Blockchain in Health Care." <https://www.bcg.com>, [www.bcg.com/publications/2018/prescription-for-blockchain-healthcare.aspx](http://www.bcg.com/publications/2018/prescription-for-blockchain-healthcare.aspx).
8. "Healthcare Rallies for Blockchains: Keeping Patients at the Center." *Blockchain, the next Disruptor for Finance*, 29 May 2018, [www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=GBE03790USEN](http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=GBE03790USEN).
9. "5 Blockchain Startups Working To Transform Healthcare." *Corporate Innovation Trends*, 21 May 2018, [www.cbinsights.com/research/healthcare-blockchain-startups-medicine/](http://www.cbinsights.com/research/healthcare-blockchain-startups-medicine/).
10. "Banking Is Only The Beginning: 36 Big Industries Blockchain Could Transform." *Corporate Innovation Trends*, 26 Mar. 2018, [www.cbinsights.com/research/industries-disrupted-blockchain/](http://www.cbinsights.com/research/industries-disrupted-blockchain/).
11. "Blockchain and GDPR." *Blockchain, the next Disruptor for Finance*, 19 Mar. 2018, [www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=61014461USEN](http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=61014461USEN).
12. PricewaterhouseCoopers. "Cyber: How Blockchain, Cloud, and Other Emerging Technologies Are Changing Cybersecurity." *PwC*, [www.pwc.com/ca/en/services/consulting/perspective/cyber-hub/cyber-how-blockchain-cloud-and-other-emerging-technologies-are-changing-cybersecurity.html](http://www.pwc.com/ca/en/services/consulting/perspective/cyber-hub/cyber-how-blockchain-cloud-and-other-emerging-technologies-are-changing-cybersecurity.html).
13. Shieber, Jonathan. "Gem Looks to CDC and European Giant Tieto to Take Blockchain into Healthcare." *TechCrunch*, TechCrunch, 27 Sept. 2017, [techcrunch.com/2017/09/25/gem-looks-to-cdc-and-european-giant-tieto-to-take-blockchain-into-healthcare/](http://techcrunch.com/2017/09/25/gem-looks-to-cdc-and-european-giant-tieto-to-take-blockchain-into-healthcare/).
14. Zochodne, Geoff. "BMO, CIBC's Simplii Financial Say Fraudsters May Have Accessed Data for Thousands of Clients." *Financial Post*, 28 May 2018, [business.financialpost.com/news/fp-street/cibcs-simplii-says-fraudsters-may-have-accessed-data-of-40000-clients?utm\\_campaign=magnet&utm\\_source=article\\_page&utm\\_medium=related\\_articles](http://business.financialpost.com/news/fp-street/cibcs-simplii-says-fraudsters-may-have-accessed-data-of-40000-clients?utm_campaign=magnet&utm_source=article_page&utm_medium=related_articles).
15. Zochodne, Geoff. "From Blockchain to Augmented Reality, Canada's Big Banks Aim to Patent the Future of Finance." *Financial Post*, 13 Apr. 2018, [business.financialpost.com/news/fp-street/from-blockchain-to-augmented-reality-canadas-big-banks-aim-to-patent-the-future-of-finance](http://business.financialpost.com/news/fp-street/from-blockchain-to-augmented-reality-canadas-big-banks-aim-to-patent-the-future-of-finance).
16. Healthcare Information and Management Systems Society ([www.himss.org/definition-continuum-care,+http://dpeafclio.org/programs-publications/issue-fact-sheets/the-u-s-health-care-system-an-international-perspective/](http://www.himss.org/definition-continuum-care,+http://dpeafclio.org/programs-publications/issue-fact-sheets/the-u-s-health-care-system-an-international-perspective/)).
17. Simpson, Chris, et al. "How Healthy Is the Canadian Health-Care System?" *The Conversation*, The Conversation, 31 May 2018, [theconversation.com/how-healthy-is-the-canadian-health-care-system-82674](http://theconversation.com/how-healthy-is-the-canadian-health-care-system-82674).
18. Sivilli, Frank. "Blockchain Technology in Healthcare: HIPAA Compliant?" *Compliance Group*, Compliance Group, 24 Apr. 2018, [compliance-group.com/hipaa-compliant-blockchain-healthcare/](http://compliance-group.com/hipaa-compliant-blockchain-healthcare/).