Tracking of COVID-19 Symptoms using Blockchain Digital Ledger

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Abstract: - The wide spread of COVID-19 virus made it compulsory for global health organizations and agencies to track and study of the COVID-19 symptoms in an effort to produce a reliable medication and vaccines. Scientists around the world are working to find and develop treatments for COVID-19. Most people who become ill with COVID-19 will be able to recover at home by getting enough rest, staying well hydrated and taking over the counter medication such as acetaminophen to relieve fever, aches, and pains. However, some people need advanced help and others need hospitalization. The FDA continues to grant emergency use authorization to two monoclonal antibody treatments for non-hospitalized adults and children over age 12 with mild to moderate COVID-19 symptoms who are at risk for developing severe COVID-19 or being hospitalized for it. The treatments are a combination of casirivimab and imdevimab, made by Regeneron; and a combination of bamlanivimab and etesevimab, made by Eli Lilly. In these patients, the approved treatment may reduce the risk of hospitalization and emergency room visits. These therapies must be given intravenously (by IV), which means a scheduling a visit in a clinic or hospital soon after developing symptoms. So, what symptoms are an indication that people need medication to prevent them from being hospitalized? The answer to this problem lies in the implementation of a Blockchain symptoms tracking system. This shall provide a reliable data that shall help scientists, researchers track COVID-19 symptoms and decide when, and what medication to provide to infected people. In this paper, we propose the development of a Blockchain symptoms tracking system to enable health organization track and collect COVID-19 symptoms in order to deliver an effective and efficient treatment.

Key-Words: - Blockchain, COVID-19, symptoms, healthcare, digital, ledger

1 Introduction

In November of 2019, the world witnessed the outbreak of COVID-19 on a global scale. By March of 2020, the World Health Organization (WHO) declared COVID-19 a pandemic. COVID-19 transmission rate was very high and worrying in all countries [17]. The number of new cases escalated on a daily basis and spread all over the world. Infection rates was reaching a record high and lead to a large death rates. Countries started to impose lockdowns and curfews for the first time in decades. The WHO started campaigns to educate people about the importance of social distancing and the wearing masks in public places. On a parallel track, scientists began studying the virus and looking for a reliable cure, but their efforts resulted in little success.

Scientists and researchers at pharmaceutical companies geared its research and development efforts to develop an effective treatment to tackle the virus [8]. They were under large pressure, and their time schedule was very tight, since there were thousands of new cases and hundreds of deaths on a daily basis. Eventually and after several trials, major pharmaceutical companies developed several trial medications to treat the infection. Regeneron Eli Lilly were among the first to develop a COVID-19 experimental cure [13].

Developing an antiviral drug is not easy, since it must be able to target the specific part of a virus's life cycle that is necessary for it to reproduce [4]. In addition, an antiviral drug must be able to kill a virus without killing the human cell it occupies not to forget that viruses are highly adaptive. Because they reproduce so rapidly, they have plenty of opportunity to mutate with each new generation, potentially developing resistance to whatever drugs or vaccines developed.

Pharmaceutical companies needed help for the world health organization and its member countries to gather COVID-19 symptoms [4]. Drug development process in still ongoing until this point in time, however the number of medications recommended is limited with shortages for many under developed countries, which rely on funding, donors and support from global organizations.

Scientists say they still have more to learn about the symptoms of Covid-19 infections, long Covid, and the new variants. Each country used its own data gathering system [16]. Some systems were manual,

and some used mobile applications, to register the symptoms of each patient. These systems did not intend to provide detailed reports to governments about the actual symptoms that people experience during the life cycle of the disease [4]. Additionally, medication side effects data were not recorded efficiently, and there is no reliable information provided by the existing data gathering systems [16]. Current systems provide flawed and inadequate data for decision makers to plan for the ordering and the delivery of COVID-19 medication.

Therefore, the introduction of a Blockchain COVID-19 symptoms tracking system that provides accurate and verified information for decision makers becomes very crucial [1]. Blockchain is a new internet based technology described as a digitized and a decentralized, public ledger of all transactions. It is growing constantly in the form of blocks residing on decentralized servers all over the internet or World Wide Web. Every transaction is recorded and in a chronological order. Blockchain advantage is the ability to follow and keep track of all recorded transactions which is replicated across hundreds of thousands of Blockchain servers distributed and connected all over the Internet [3]. Blockcahin servers or nodes receive a copy of each transaction and updated automatically. The decentralized nature of the Blockchain platform make it a tamperproof system, leading to authentication of each transaction [19]. Blockcahin transaction are encrypted using hash-256 code and deposited in the Blockchain, making it impossible to alter the content of deposited timestamped transactions [13]. Confirmed transactions mean that each transaction have been replicated across a large number of nodes, making it even more impossible to delete or update its content.

This paper propose the development of a Blockchain symptoms tracking system, a system designed to provides confidentiality and trust in the data collection and reporting of COVID-19 symptoms [2]. Such a tracking system is a priority, since many of the currently used systems do not provide trusted, secured, and accurate data for decision makers, and does not guarantee or preserve the privacy of patients.

2 Literature Review

This literature review provide background information related to the COVID-19 pandemic and its symptoms. We explain the importance of adopting Blockchain technology in tracking and symptoms of COVID-19 to help drugs manufactures develop a reliable and effective medication.

2.1 COVID-19 Symptoms

It's been more than a year since Covid-19 was labeled a pandemic. Its large array of symptoms like coughing, fever, shortness of breath, and loss of taste and smell became very familiar among doctors around the world [20]. Hospitals and research labs all over the world are testing many different therapies on COVID-19-positive patients in an effort to find a potential COVID-19 treatment **[16].** . Medical researchers have also learned more about how a Covid-19 infection can ripple through the circulatory, nervous, and immune systems with symptoms like rashes, blood clots, strokes, and even foot lesions. They're also more familiar with the more than 10 percent of Covid-19 survivors who are reporting long-term symptoms, including difficulty thinking and focusing, heart palpitations, hair loss, and mood swings.

Remdesivir is currently the only medication approved by the FDA to treat coronavirus disease. The approval was based on findings that hospitalized patients who got remdesivir recovered faster **[16].** There are currently many clinical trials in process to study other potential therapies, such as monoclonal antibodies, for COVID-19. Researchers are also testing older medications that are typically used to treat other conditions to see if they are also effective for COVID-19 **[20]**.

However, researchers are still finding new symptoms. Tim Spector, a professor of molecular epidemiology at King's College London, has been studying Covid-19 throughout the pandemic through a Covid-19 Symptom Study smartphone app. He recently started receiving reports of mouth ulcers and something he calls Covid tongue — a fuzzy yellow-white coating on the tongue **[8].**

There are different types of experimental COVID-19 medications. Currently there are several major manufacturers of COVID-19 medications **[16]**. The viability of each drug depends on fight the virus. All available treatments are experimental and their side effects are under continuous investigation.

Symptoms tracking and side effects reporting is also an important aspect of the drug production process. It starts immediately after the infection is determined to be positive, and keeps on going until the patient recovers.

2.2 Blockchain research

Blockchain stores information across a network of personal computers making them not just decentralized but distributed. This means no central company or person owns the system. Yet everyone can use it and help run it [8]. This is important because it means it is difficult for any one person to take down the network or corrupt its content. The people, who run the system, use their computers to hold bundles of records submitted by others, known as blocks in a chronological chain **[14, 15]**. The Blockchain uses a form of math called cryptography to ensure that records cannot become counterfeited or hacked by anyone else.

A Blockchain is a chain of blocks that contains information **[7]**.This technique was originally described in 1991 by a group of researchers and was originally intended to timestamp digital documents so that it is not possible to backdate them or to tamper with them almost like a notary. However, it went by mostly unused until Satoshi Nakamoto adapted it in 2009 to create the digital cryptocurrency Bitcoin **[18]**.

Blockchain main logic is to have digital information distributed and note copied forming a new era of the internet, and sometimes industry experts call it Web 3.0. A Blockchain is a distributed ledger that is completely open to anyone. They have an interesting property, once data have been recorded inside the Blockchain; it becomes very difficult to alter of change if not impossible.

3 Proposed Blockchain Vaccination Tracking System

Blockchain proved to be a reliable technology used for authentication and verification. We propose a Blockchain symptoms tracking system that is secure and allows people to retain ownership over their own data while allowing health care authorities to have full and easy access (see Fig. 1) to the symptoms data. The system built on smart contract and public ledger technology, provides a reliable means for tracking the vaccination process without disclosing people identities or private information.

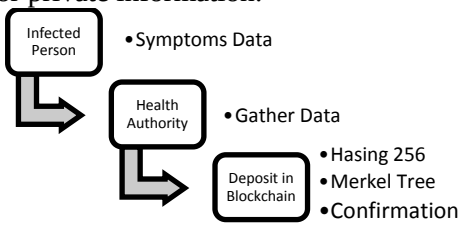

Fig.1 Proposed Tracing System

The system collects symptoms data online through a dedicated application available on mobile devices and smart boards. Our proposed system designed independent of both Ethereum and Bitcoin services. Third party system that process the creation of each transaction and storing it in the Blockcahin is needed to expedite the development process **[22].** Each symptoms record is assigned a unique hash generated at the beginning of the vaccination transaction and the hash is then deposited in the Blockchain [11]. Data is encrypted so that Blockchain records are kept private and secured. Thus, the root chunks are securely stored in smart contracts through the Blockchain, and released only under specific conditions.

3.1 Hashing

The proposed system uses Blockchain technology to provide a tamper-proof timestamp irrefutably proving the existence of the symptoms record **[23].** The system encrypt the transaction into a secure hash, which is, a number generated from the symptoms data as shown below:

sha256("COVID-19 Symptoms ") = 355bce6b96ee0790bb87357f7a0cf3207a8f51e49d62ee08eade3b038ea8e8

The generated hash is deposited in the Blockchain and a timestamp is created for the transaction. It is impossible for the hash to be converted back to its original form (data that was encrypted), it is just impossible to do that realistically **[6]** and **[22].**

To explain the process, simply let calculate the hash for the sum of number 71, being 8. This sum may also result from adding 62, 53 and 44, therefore it is impossible to reconstruct 71 by reverse engineering. We cannot tell what numbers were added up to 8 if you only know the result.

digitsum(71) = 7+1 = 8

digitsum(62) = 6+2 = 8

digitsum(53) = 5+3 = 8

digitsum(44) = 4+4 = 8

Therefore, it is impossible to know what is the number used to calculate the hash; however, the hash is "unique" for each number used in calculating the hash:

sha256(71) = 7f2253d7e228b22a08bda1f09c516f6fead81df6536eb02fa991a34bb38d9be8

sha256(62) = 81b8a03f97e8787c53fe1a86bda042b6f0de9b0ec9c09357e107c99ba4d6948a

sha256(53) = 2858dcd1057d3eae7f7d5f782167e24b61153c01551450a628cee722509f6529

sha256(44) = 71ee45a3c0db9a9865f7313dd3372cf60dca6479d46261f3542eb9346e4a04d6

The hash code is calculated locally on the client machine for confidentiality and is kept on the local server **[12].** The generated hash is then deposited in a Blockchain transaction and a timestamp is created for each transaction (https://emn178.github.io/online-tools/sha256.html). This time stamp can be used for verification of the time date the transaction was used and it is linked back to the symptoms data through the hash code.

3.2 Blockchain Technology

Generating a time stamp from the hash is where the Blockchain technology come into play. The Blockchain is a digital chain of blocks, each block contains transactions, this where hash is encoded into a timestamp **[22]**. The Blockchain works by linking bocks together, each block depends on its predecessor in a way such that any attempt to change or alter the content of any transaction is impossible **[21]**. The next step in the Blockcahin is confirmation of blocks using several concepts including (Proof of Work and Proof of Stake). This is where Blockchain stake holder are rewarded with digital tokens

for investing time, computational energy to preserve the Blockchain in a stable agreed upon state.

3.3 Private Key

The final step in the proposed system handles how to insert the symptoms record transaction hash into a Blockchain block. To be able to do that, we need to create a private key from the v symptoms -generated hash, and a transaction involving the generated public key is then submitted to the Blockchain **[5]** and **[9, 10]**. This takes us to a reliable tamper proof chain of the original symptoms data to a tamper-proof timestamp generated and preserved in the Blockchain:

1- Generate the hash for the symptoms data
2- Aggregate the symptoms hash and many others generated hashes through a Merkle Tree into a new aggregated hash (to lower the costs of the transaction)
3- Generate a private key from that aggregated symptoms hash, and from that a public key / address.
4- Submit a transaction involving this public key / address
5- Once the transaction is confirmed by the Blockchain network, which usually needs about an hour, the symptoms timestamp is irrevocably embedded in the Blockchain

4 Discussions

Since the COVID-19 pandemic is a new issue. There are no prior literature covering this domain. Some Blockchain applications have been in use in limited areas of the supply chain systems in the health care filed, but none has explained the importance of Blockchain-based healthcare solutions use in the gathering of COVID-19 symptoms. Pharmaceutical organizations can use the proposed system to improve streamline of the COVID-19 symptoms data to develop an efficient medication to tackle the existing COVID-19 pandemic.

Our proposed Blockchain symptoms tracking system shall preserve and deposit symptoms data in the Blockchain a secure private manner. The system help health care agencies to record and track the symptoms, and the any possible side effects for experimental medication that may have on the general population.

This research has the potential to make a significant impact on governments and healthcare agencies through presenting the importance of deploying a Blockchain symptoms tracking system. Governments and healthcare agencies shall appreciate the use of the Blockchain technology to assist in tracking and monitoring of the COVID-19 symptoms. The implementation of Blockchain symptoms tracking system will facilitate communication in real time, identify any issues during drug development, and allow for better efficiency in the use of limited resources. The implementation of Blockchain to gather COVID-19 symptoms for the use of health care organization can help track the symptoms throughout the life cycle of the disease. The major advantage of using Blockchain technology are: improved assistance in gathering authentic data, improved assistance in tracking symptoms and, improved overall medication productivity and efficiency.

5 Conclusion

In this paper, we introduced a Blockchain-based tracking system for tracking, and monitoring COVID-19 symptoms. The proposed Blockchain-based solution promotes trust, transparency, and traceability. It also streamlines the communication between stakeholders. Research about Blockchain's applications in healthcare is currently limited; however, more research becomes available every day. Our presented system addresses the problems health care organizations is facing in the development of a cure for the current pandemic. The system provides a reliable solution that shall help scientists and researchers track the symptoms and keep accurate, authentic records. A Blockchain system shall provide authentic data about the type and number of COVID-19 symptoms globally. The Blockchain system shall facilitate the production of the COVID-19 treatment and shall help countries learn, and make decisions on how to plan and manage the treatment of new cases. In this paper, we propose the development of a Blockchain symptoms tracking system to enable health care organizations deliver a reliable COVID-19 medications to the general population effectively and efficiently.

References:

[1] Abdullah, N., Håkansson, A., Moradian, E., Blockchain based approach to enhance big data authentication in distributed environment. In: International Conference on Ubiquitous and Future Networks. ICUFN, 2017. pp. 887–892.
[2] Al Omar, A., Rahman, M.S., Basu, A., Kiyomoto, S., 2017. MediBchain: A blockchain based privacy preserving platform for healthcare data. In: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol. 10658 LNCS, pp. 534–543.
[3] Al-Zagheer, H., 2017. A proposed Model linking Human Resources Information Systems with Strategic Human Resources Planning to Achieve Competitive Strategy, Asian Journal of Information Technology, Volume 16(6), pp. 521-526.
[4] Annisa, Muhsinah; Asrani, Asrani., 2020. Digital Dissemination COVID-19 Dwibahasa (Indonesia Dan Banjar) Melalui Literasi Sains Visual Dan Multimedia. Elementary School Journal Pgsd Fip Unimed ; 10(2):56-65.

[5] Bdiwi, R., De Runz, C., Faiz, S., Cherif, A.A., 2017. Towards a New Ubiquitous Learning Environment Based on Blockchain Technology. In: Proceedings – IEEE 17th International Conference on Advanced Learning Technologies, ICALT 2017, pp. 101–102.

[6] Biryukov, A., Khovratovich, D., Pustogarov, I., 2014. Deanonymisation of Clients in Bitcoin P2P Network. In: Proceedings of the 2014 ACM SIGSAC Conference on Computer and Communications Security, CCS '14. ACM, New York, NY, USA, 201;7 pp. 15–29, ISBN 978-1-4503-2957-6, doi: https://doi.org/10.1145/2660267.2660379.

[7] Bracamonte, V., Okada, H., 2017. An exploratory study on the influence of guidelines on crowdfunding projects in the ethereum blockchain platform. In: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol. 10540. LNCS, pp. 347–354.

[8] Carole H. Sudre, Benjamin Murray, et al. Attributes and predictors of Long-COVID: analysis of COVID cases and their symptoms collected by the Covid Symptoms Study App

[9] medRxiv 2020.10.19.20214494; doi: https://doi.org/10.1101/2020.10.19.20214494

[10] Chen, J., Xue, Y., 2017. Bootstrapping a blockchain based ecosystem for big data exchange. In: Proceedings – 2017 IEEE 6th International Congress on Big Data, BigData Congress, pp. 460–463.

[11] Dorri, A., Kanhere, S.S., Jurdak, R., 2017. Towards an optimized blockchain for IoT. In: Proceedings – 2017 IEEE/ACM 2nd International Conference on Internet-of-Things Design and Implementation, IoTDI 2017 (part of CPS Week), pp. 173–178.

[12] Dubovitskaya A, Xu Z, Ryu S, et al., 2017. Secure and Trustable Electronic Medical Records Sharing using Blockchain. AMIA Annu Symp Proc, pp. 650–659.

[13] Fan K, Wang S, Ren Y, Li H, Yang Y, 2020. MedBlock: Efficient and Secure Medical Data Sharing Via Blockchain. J Med Syst, Volume 42, pp. 136.

[14] Griggs KN, Ossipova O, Kohlios CP, Alessandro N Baccarini, Howson Emily A, et al., 2018. Healthcare Blockchain System Using Smart Contracts for Secure Automated Remote Patient Monitoring. J Med Syst, Volume 42, pp. 130.

[15] Ichikawa D, Kashiyama M and Ueno T, 2017. Tamper-Resistant Mobile Health Using Blockchain Technology. JMIR Mhealth Uhealth, Volume 5(7), pp. e111.

[16] Ji, Wei. , 2021. Coronaviruses: What Should We Know About the Characteristics of Viruses? Adv Exp Med Biol ; 1318: 23-39.

[17] Ji Y, Zhang J, Jianfeng Ma, Chao Yang, Xin Yao, et al., 2018 BMPLS: Blockchain-Based Multi-level Privacy-Preserving Location Sharing Scheme for Telecare Medical Information Systems. J Med Syst, pp. 42-147.

[18] Mamoshina P, Ojomoko L, Yanovich Y, et al., 2018. Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. Oncotarget, Volume 9, pp. 5665–5690.

[19] Masadeh, R., Almajali, D.A., Alrowwad, A., Obeidat, B. 2019. The role of knowledge management infrastructure in enhancing job satisfaction: A developing country perspective. Interdisciplinary Journal of Information, Knowledge, and Management, Volume 14, pp. 1–25

[20] Persoon, I F; Volgenant, C M C; van der Veen, M H; Opdam, N J M; Manton, D J; Bruers, J J M., 2021. Impact of the coronavirus on Dutch oral health care and practice. Ned Tijdschr Tandheelkd ; 128(4): 211-220.

[21] Qutqut, M.H., Al-Sakran, A., Almasalha, F., Hassanein, H.S., 2018, Comprehensive survey of the IoT opensource OSs. IET Wireless Sensor Systems, Volume 8(6), pp. 323–339

[22] Shkoukani, M., Lail, R.A., 2013. General and special-purpose methodologies for agent oriented software engineering. Journal of Theoretical and Applied Information Technology, Volume 48(1), pp. 138–144

[23] Wang H and Song Y, 2018. Secure Cloud-Based EHR System Using Attribute-Based Cryptosystem and Blockchain. J Med Syst, Volume 42(8), pp. 152.