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## Towards Universal Healthcare Coverage Through Adoption Of Blockchain Technology: A Literature Review

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Countries in low and middle income countries (LMICs) are embarking on a path to achieve universal healthcare coverage (UHC) for its populace. The growth is evidenced by the renewed commitment by governments, both from a policy and implementation perspective, to providing affordable healthcare for all of its citizens by increasing financial risk protection through the National Health Insurance Funds (NHIF), even adding more benefits targeting informal sector households and adjusting outpatient cover; to improve access to health and improve the national health outcomes.

Despite these commendable efforts, there are still several challenges facing the health provision in LMICs. High poverty levels, increased unemployment rates, high cost of care, disparate information systems and weak data use culture, inadequate funding, inadequate tax collection system, corruption, weak management and oversight by regulator, insufficient skilled personnel and difficulties in identifying and reaching the most vulnerable citizens, are all challenges that have impacted negatively on health.

The potential uses of blockchain technology in healthcare are multiple; blockchain technologies have advanced and have matured to hold the promise to unite the disparate processes in the pharmaceutical industry and healthcare ecosystem, reduce costs, improve regulatory compliance, increase data flow, and improve patient experience and outcomes.

The objectives of this paper is to present a review of published articles and journals that discuss the applications of blockchain technology in healthcare in order to gain knowledge about methodologies used and findings obtained from the implementation of blockchain solutions in healthcare settings.

Literature review included critical assessment of 19 papers to identify studies that examine the use case for blockchain technology in healthcare.

The findings show that Blockchain proves to be key in building a global precision-medicine ecosystem that optimally connects patients, clinicians, researchers, insurers and clinical laboratories to one another. Blockchain can improve patient data security, data sharing, interoperability, patient engagement, big data analytics, health information exchange, fighting counterfeit drugs, R&D processes, AI-based diagnostics and fostering vertical business models. Other potential breakthroughs in the healthcare ecosystem are not limited to cost reduction, improve regulatory compliance, increase data flow, and improve patient experience and outcomes.

**Keywords:** Blockchain, NHIF, UHC, LMICs, FHIR, smart contracts

### 1 Introduction

Blockchain is a network of distributed databases or public records of transactions which do not need permissions in a chronological order. It is shared and maintained by multiple parties that secure all the records that are added to it. Each transaction contains a timestamp and secure links to the previous one. Records can only be added to the database and cryptographically linked to all previous one and can never be deleted. Addition of new records is done once the parties managing the databases are on the synchronous

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agreement or “distributed consensus”. It is hard for one individual to manipulate cryptographically linked past records without breaking the overall consistency of the database.

Blockchain technology entails having an infrastructure that creates decentralized digital public records of transactions that are secure, anonymous, unchangeable and tamper proof. This has attracted technology giants such IBM Watson and Microsoft who are already working to provide Blockchain-as-a-Service (BaaS) products where developers can create and test a blockchain on the cloud.

Bitcoin was the first blockchain implementation as a digital financial asset in widespread use.[2] It is an electronic payment system based on cryptographic proof instead of trust. Although Bitcoin seemed to be a suitable technology for preventing data tampering in medical arena, it is currently not appropriate for following reasons: (1) it is an open network that anyone can join, (2) it needs massive computing power to guarantee tamper resistance and (3) it deals with currency which is only one-dimensional data. [3]. Nevertheless, in private network blockchain system, that prerequisite permission to join has been developed; this system can handle multidimensional data and does not require massive computing power for effective tamper resistance[4]

Blockchain can maintain endlessly growing lists of data records and secured transactions and has the power to potentially transform health care and revolutionize the way data is processed in areas as health data interoperability, revenue cycle management, and validation of supply chain, blockchain has the potential to dramatically reduce back-office data input and maintenance costs and improve data accuracy and security according to the industry experts.[5]

## **2 Application of Blockchain technology in healthcare**

The following is a summary of blockchain capabilities that make it a potentially useful technology tool for healthcare data interoperability; creating secure and trusted health record data; linking identities while preserving the anonymity of patient encounter and other transactional data, and recording patient consent.

### **2.1 Secure patient data access**

Blockchain technology can provide a patient with a security key that matches that of their provider’s allowing them to access their longitudinal care records. A typical patient care workflow for this includes a scenario where a patient with a private key, and an address that provides the codes to unlock their patient data, is matched with a healthcare provider universal signature. When the two are combined, the required authentication to unlock the patient’s data is established. The patient defines in their profile, the access rules required to unlock their medical records. In this case, preventing unauthorized access to patient data becomes very easy.

Blockchain provides the authentication to enable access (identification and authentication) to the requested data and also offers a non-reputable audit trail which guarantees the records’ validity, and that a patient record was authentically signed and certified. Blockchain would enable peer-to-peer interoperability among participants within transactions using smart contracts and fully auditable history. The advantage of blockchain transactions being cryptographically and unchangeable safeguards privacy across parties. The patient using keys (either public or private) would be able to designate by whom the access the data.[11]

### **2.2 Health data exchange and interoperability using blockchain technology.**

The adoption of digital health solutions and particularly electronic medical records (EMRs) in Africa has also been on the rise over the past decade. Both primary and secondary health care facilities, that traditionally recorded patient records manually, have embraced digital health systems for recording patient data and overall patient management.

At the same time, EMRs store highly sensitive patient data for diagnosis and treatment, which needs to be distributed and shared frequently among peers such as healthcare providers, insurance providers, pharmacies, researchers, patient’s families, among others, to realize their true potential. Ensuring the patient’s medical history is up-to-date is a challenge. Patient’s treatment process gets complicated when multiple entities are involved in storing and sharing data.

Patients suffering from serious ailments like cancer or HIV/AIDS, need to have a well-maintained history of their treatment processes. Having access to a complete history is paramount to ensure treatment and continuation of care. [7] states that a patient has right to information; every patient is entitled to receiving and access full and accurate information concerning their health and health care. This also limits who has access to their health information. If patients need to share their health information with another healthcare provider they need to consent, despite this a security risk when the patients' information is in transit.

Depending on the centralized entity that would store and manage the patients' data, access control policies means having a single point of failure, which could be a bottleneck for the whole framework. It also requires either conducting all the operations (such as search, or anonymization) over encrypted data or choosing a fully trusted entity that will have access to sensitive information about the patients.[8]

It is possible to overcome issues mentioned above by having a ledger - an open, immutable, and transparent record of all the activities happening in the network (such as a patient modification, a physician uploading new data and disseminate them for research). It is by having mutual agreement among distributed entities without trusting any party, that blockchain technology will guarantee security, control over sensitive data, and will smoothen healthcare data management for the patient and stakeholders in the medical domain.[8]

Blockchain can support interoperability across systems and organizations. This is crucial for advancement in our current health ecosystem which consists of disparate IT legacy systems which do not communicate with each other. Blockchain can provide a single system that offers interoperability to replace these disparate systems with.

### 2.3 *Automated health claims adjudication*

Another blockchain revolution is to verify the claim transactions to support health care financing tasks (i.e., health plan claims), such as preauthorization payment, alternative payment models, automated claims using Fast Healthcare Interoperability Resources (FHIR) and smart contracts.[14]

A smart contract structure enables a node to perform a transaction for the contract. This logic guarantees correct completion of claims and supports compliance audits using business rules [17]. Some positive strides have been taken by different individuals to explore the possibilities of blockchain technology.

Blockchain provides a decentralized management where real-time claim processing happens without intermediaries. This feature will replace the health plan intermediation by having claims adjudication in real-time using transparent blockchain technologies.[15] Based on Blockchain immutability there is improved claim auditing and fraud detection: "Payer, private and government insurers, and individual payers have the benefits of audits facilitation and better fraud detection"[16]

## 3 **Materials and methods**

A literature review was conducted for published research studies and articles on application of blockchain technology in healthcare. The search for the related material started in January 2018 and finished in April 2018. Journal of Medical Informatics, Research Gate and directory of open access journals (DOAJ) and the internet at large, were some of the databases used to access articles and papers on this subject. The keywords used to search for the articles were: blockchain, blockchain in healthcare, smart contracts in healthcare, digital health, health information management, patient data security, secure access to patient data. The review was limited to articles and papers published between 2000 and 2018 and in English. We hit 19 articles.

## 4 **Conclusion**

Further research is suggested to focus on the cost associated with the deployment of blockchain technology, the capacity of systems integrators to adapt to changing technology and ongoing maintenance of systems. In addition to that, it is suggested that deployment of blockchain applications be incremental in nature as with any emerging technology.[11] A project such as MedRec has led to demonstrate how we can lead to

interoperable and secure EHR systems using decentralization and blockchain architectures. They are prioritizing open APIs and network structure transparency.[12] Other studies such as the tamper-resistant mHealth solution based on blockchain technology which was able to confirm that mHealth data is compatible with blockchain technology, need to be further examined and replicated across the numerous mhealth solutions used in LMICs.

There are fears with vulnerability around the blockchain system, the implementations around it can be attacked despite it known for tamper-resistance. Poorly maintained and out-of-date codes in an incident involving a decentralized autonomous organization made it vulnerable.[18]

Blockchain technology is envisaged to enable near real-time transactions and faster, however, the cost of operating such as system is not yet known. there are scarce blockchain solutions in complete operation, and with this in mind, it is hard to forecast the possible costs of operating a blockchain at scale. Consequently, there should be targeted experiments and common blockchain solutions to iteratively assess the technology with a view to scale and understand the possible cost of the fully scaled blockchain.[19]

Regulatory consideration is crucial to blockchain advancement; this should also fit within the existing regulatory frameworks. Despite regulations like the Health Insurance Portability and Accountability Act (HIPAA), it is still evident that healthcare organizations still aren't doing enough to protect themselves from cyber-attacks.[1] They need to take a step to prevent future incidents and one possible way is in the decentralization of healthcare data through blockchain

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