Blockchain Data Management for Pharmaceuticals

Shih-Shuan Wang[1], Alexandru Dinu[2], Eugen-Silviu Vrăjitoru[3], Aleksander Ryszard Izemski[4], Alin Mihai Meclea[5], Mircea Boscoianu[6]

[1 3 5 6] Faculty of Technological Enginnering and Industrial Management, Transilvania University of Brasov
[1 2] Electronics and Computers Department, Transilvania University of Brasov
[4] Faculty of Computer Science and Telecommunications, Poznan University of Technology
[6] National Institute for Aerospace Research "Elie Carafoli"

jacquesdemolay03@gmail.com, alexandru.dinu@unitbv.ro, eugen.vrajitoru@unitbv.ro
AleksanderIzemski@gmail.com, mihai.meclea@unitbv.ro, boscoianu.mircea@incas.ro

Abstract

The care and quality provided to service users depend heavily on the documentation of medication administration. The results of medication management will be greatly impacted by the Medication Data Management (MDM) sheets, which will be examined during audits. Along with this impact, registered hospitals, care facilities, and residential homes will all be inspected by the healthcare industry. In order to deploy MDM sheets, it is proposed to create a blockchain prototype, or more specifically, to develop a blockchain-based Electronic Health Records (EHR) application. Confidentiality and confidence with the auditors are provided by the usage of permissioned blockchain technology (e.g., Care Quality Commission - CQC). Results from testing the prototype in two scenarios are positive. According to the findings, the use of EHR with permissioned blockchain can result in reminders being sent to medical practitioners as well as other effects.

Keywords— Medication Data Management, Electronic Health Records, Care Quality Commission, Blockchain

1. INTRODUCTION

A crucial step in assuring the superior quality of treatment delivered by medical personnel is the administration of medications. To document the details of the medication administration by medical professionals to the clients they serve.

Healthcare practitioners utilize a sheet for keeping track of medication administration. Reminders sent to healthcare workers can result in only minor improvements to medication management, however employing automated systems can result in large improvements [1] [2]. As a result, while the design, development, and deployment of a computerized system for finishing MDM sheets are not novel, the capacity to deploy MDM sheets utilizing blockchain technology is novel, as are the potential benefits it may offer.

Since Nakamoto (2008)'s Bitcoin is the source of all blockchain-based apps, it is challenging to produce a paper on blockchain without addressing it. To keep track of the exchange of funds between two or more Bitcoin wallets, the cryptocurrency uses the blockchain. Thus, what is blockchain? It is essentially a consensus-based, append-only encrypted ledger that cannot be modified manually. Blockchain is perfect for auditability for two reasons, both of which are crucial. Data added to the blockchain via the append-only method is immutable, meaning that it cannot be modified without a great deal of work; and consensus - a decentralized component mandates that all nodes in the network reach consensus before updating, which fosters confidence among network participants.

When exchanging things of value, tokens or coins are frequently utilized; however, as things of value are not always traded, tokens are not always necessary in many applications. Blockchain for Medication Data Management (BMDM) will be tokenless because, although information is transferred, it has no monetary value and is thus not worth exchanging.

Last but not least, there are two key distinctions between permissioned and permissionless blockchain application implementation. The consensus nodes can be added without the system's consent when a system is permissionless. When compared to permissioned blockchain, which only permits authorized nodes to join the network and has the added benefit that further limitations may be put on particular users while still maintaining data privacy to only those nodes.

Finally, the developed application makes use of a tokenless permissioned blockchain, producing data that is append-only and immutable. Which, owing to the encryption used in blockchain technology, is excellent for audits and ensures data privacy.

2. DESIGN AND DISCUSSION

In medication data management, there are a few important informational exchanges that should be noted. Data that is at least partially anonymized

would need to be stored during transactions. Registry references to unique identifiers on the blockchain that are recorded in the system can be deleted, protecting people's rights. However, see [3] for further details on how data is secured and safeguarded on permissioned blockchain apps (Fig. 2).

A. *Protection of data*

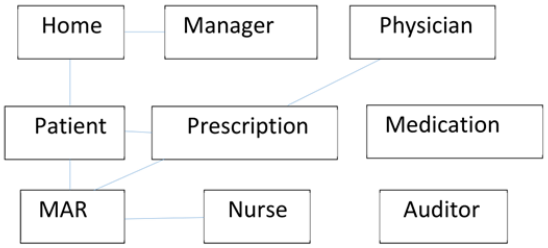

Fig. 2 Simplified class diagram for BMAR, omitting attributes (original picture can be found in [4])

In the UK, all e-Health apps must adhere to the seven Caldicott principles [5]. The following factors were taken into account when designing the system for BMDM.

B. *Prescription*

Although prescriptions are beyond the purview of Blockchain Medication Data Management (BMDM), it is understood that a competent person, such as a doctor, would need to do so in order to prescribe medication. By no means should the flowcharts in Fig. 3 or the other flowcharts be used in place of the GP's knowledge. The flowcharts do, however, include the procedure for writing a prescription, paying special attention to the choice of a service user and the writing of new or repeat prescriptions. When everything is finished, the doctor chooses another Service User (SU) or chooses the same service user to write another prescription. These procedures irritate the user and do not imitate the process of writing several prescriptions. This is the method, which makes issuing several prescriptions possible to do so simultaneously.

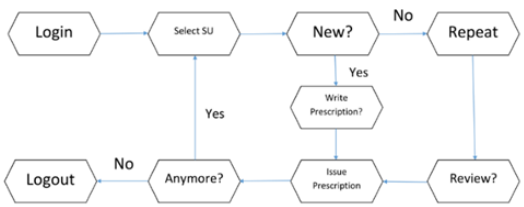

Fig. 3 shows a flowchart for finishing a prescription. (Note that this application has been simplified because it is not intended to execute prescription processes and procedures; original picture can be found in [4])

C. *Medication Data Management*

For the service-wellbeing, user's it is crucial to complete the Sheet of medication data management. The only claim made by BMDM is that it can be used and that all activities can be recorded without changing the protocol. In fact, the repercussions of implementing automated systems call for prudence if this were to be put into practice, for instance, a post-completion mistake, where a Healthcare Professional who is appropriately qualified fills out the form but neglects to finish the duty and give the medicine; see for further details [6]

There is evidence that the adoption of such technology may improve medicine delivery, however caution and more studies are advised [2] [7] (Fig. 4).

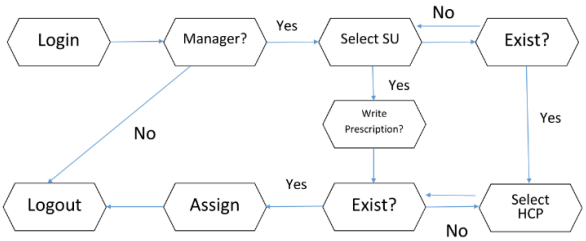

Fig. 4 Flowchart for completion of assigning keyworker to service-user (Patient). (Abbreviations: HCP Healthcare Professional) (original picture can be found in [4])

Fig. 5 Flowchart for registering a service-user with a healthcare provider (original picture can be found in [4]).

D. *Observation of a medical nature*

As would be predicted, Fig. 6 illustrates how the technique for monitoring medicine is comparable to that for administering it. Medication Administer Codes (MAC) can be values such as taken, refused, vomit, sleeping or absent All restricted substances must go through this procedure.

Fig. 6 Flowchart for completion of observation for Medicine Administration Records (MAR) sheet (original picture can be found in [4]).

In simultaneously with the person administering the medication, the observer logs in after choosing the appropriate service user and related prescription. The observer enters the appropriate MAC once the drug has been delivered. The procedure is repeated if there are several prescriptions. The audit can identify some abnormalities, such as when an observation is added to the blockchain as a transaction prior to the administration. The audits covered in section below cover these and other questions.

E. Inspected and Secure

An auditing organization would have access to all data and transactions on the system with "read access", such the CQC. Each healthcare practitioner can respond to predefined enquiries that are classified by domicile as well as a client. Although the aggregation of these data frequently makes it challenging to spot abnormalities, search engines may be implemented and queries can be created to identify any potential problems. For instance, it is possible to self-audit a MDM sheet inaccuracy and leave it to the auditor's judgment to interrogate the care home management. Although this is nothing new, utilizing blockchain technology to ensure an independent mediatory append- Just the innovative record on MAR Medication Data Management (BMDM) sheets makes it difficult to later remove or modify. Arguments for a fictitious 51% are frequently brought up in relation to permissionless blockchain technology [8].

First off, it is novel to use blockchain technology to ensure a disintermediate append-only record of MDM sheets that is difficult to later delete or correct. Arguments against the fictitious 51% is substantially reduced with permissioned blockchain. Second, because the PBFT consensus method [9], which is utilized, demands a larger percentage of agreement, such an assault would call for modifying more than 2/3 of the nodes. Despite having a very low chance of success, this permissioned blockchain vulnerability is theoretically feasible and is covered in Zyskind's paper [10] for additional information. Because Hyperledger Fabric requires participant certification and the transaction process is entirely encrypted, it offers a security architecture for authorisation and authentication.

3. CONCLUSIONS

For example, in [11][12][13][14] numerous blockchain-based healthcare systems have been suggested. Each of these suggested systems has value, but the BMDM prototype was created for drug administration data recording and auditing are the planned uses of a distinct program.

With the overarching goal of enhancing healthz care and protecting vulnerable persons, all of the Caldicott principles were taken into consideration when developing this program, and a practical application would be the reduction of MDM sheet errors.

For the security and anonymity needed for health informatics, there is a permissioned blockchain application. It is the best technological answer for the MDM sheet issue since the data is unchangeable and permanent. It was taken into account during the design and implementation phases that most of the data would already be available as EHR. The usage of EHR in an existing database would very certainly be required for such an implementation, therefore, it is recommended to keep registries largely static because it is the transactions that change.

Due to such architecture, databases are kept mostly static and rely on blockchain for transactions and update. As a suggestion, it is helpful to identify transactions while creating a blockchain application.Because there isn't a common modeling approach for blockchain yet, developing applications continues to be difficult. Building blockchain applications is advised to use rigorous modelling methodologies, particularly for modeling and differentiating between data about participants, assets, and transactions

REFERENCES

[1]S, Shea B et al, "Effect of computerized physician order entry and a team intervention on prevention of serious medication errors." JAMA 280(15):1311–1316, 1998

[2]Bennett JW, "Glasziou PP et al Computerised reminders and feedback in medication agement: a systematic review of randomised controlled trials." Med J Aust 178(5):217–222, 2003

[3]Hyperledger architecture Volume 1." https://www.hyperledger.org/wp-content/uploads/2017/08/HyperLedger_Arch_WG_Paper_1_Consensus.pdf. Accessed July 2018

[4] Jahankhani H, (ed.), Kendzierskyj S, (ed.), Jamal A, (ed.), Epiphaniou G, (ed.), Al-Khateeb H, (ed.). Blockchain and Clinical Trial: Securing Patient Data. 1 ed. 2019. 267 p. (Advanced Sciences and Technologies for Security Applications (ASTSA)). Epub 2019 Apr 18. doi: 10.1007/978-3-030-11289-9

[5]Caldicott F, "Information: to share or not to share? The information governance review." Department of Health, UK, 2013

[6]Yau Wai LI, Blandford A, Cairns P , Young RM, et al"Post-completion errors in problem solving", 2005

[7]Bates DW, Leape LL, Cullen DJ, Laird N, Petersen LA, Teich JM, Burdick E, Hickey M, Kleefield S, Shea B et al "Effect of computerized physician order entry and a team intervention on prevention of serious medication errors." JAMA 280(15):1311–1316, 1998

[8]Bastiaan M, "Preventing the 51%-attack: a stochastic analysis of two phase proof of work in bitcoin. In: Available at http://referaat.cs.utwente.nl/conference/22/paper/7473/preventingthe-51-attack-astochastic-analysis-of-two-phase-proof-of-work-in-bitcoin.pdf", 2015

[9]Castro M, Liskov B et al "Practical byzantine fault tolerance." In: OSDI, vol 99, pp 173–186 Council of European Union (2018) Council regulation (EU) no 2016/679. http://eur-lex.europa.eu/legal-content/en/LSU/?uri=CELEX\%3A32016R0679. Accessed July 2018

[10]Zyskind G, Oz N, et al "Decentralizing privacy: using blockchain to protect personal data. In: Security and privacy workshops (SPW)." IEEE, 180–184, 2015

[11]Azaria A, Ekblaw A, Vieira T, Lippman A Medrec, "using blockchain for medical data access and permission management." In Open and Big Data (OBD), International conference on. IEEE, Los Alamitos, pp 25–30, 2016

[12]Griggs KN, Ossipova O, Kohlios CP , Baccarini AN, Howson EA, Hayajneh T, "Healthcare blockchain system using smart contracts for secure automated remote patient monitoring." J Med Syst 42(7):130, 2018

[13]Vithanwattana N, Mapp G, George C, "Developing a comprehensive information security framework form health: a detailed analysis." J Reliab Intell Environ 3(1):21–39, 2017

[14]Zhang P , White J, Schmidt DC, Lenz G, "Applying software patterns to address interoper- ability in blockchain-based healthcare apps.", 2017