



Blockchain technology in e-health: The case of electronic prescriptions in Germany

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Abstract

Traditionally, healthcare has been a laggard when it comes to adopting advances in technology; however, this time lag appears to be decreasing more recently and we are witnessing the embracement of blockchain technology in healthcare. Examples of blockchain technology in e-health are to date focussed mostly on electronic health records. The process of electronic prescriptions and medication management has not as yet been considered. This process offers a variety of opportunities for automatization and digitalization. Further, there is a significant potential for cost savings not only for insurance companies. At the moment, research on blockchain technology seems to be technology driven. We content to be truly beneficial, further research needs to also focus on patients' acceptance as well as major barriers and facilitators.

Key words: Blockchain, smart contract, e-health, electronic prescription

1. INTRODUCTION

Blockchain is one of the most often used buzzwords of the last months. Gartner proposed in July 2016 that blockchain would reach the peak of inflated expectations very soon [1].

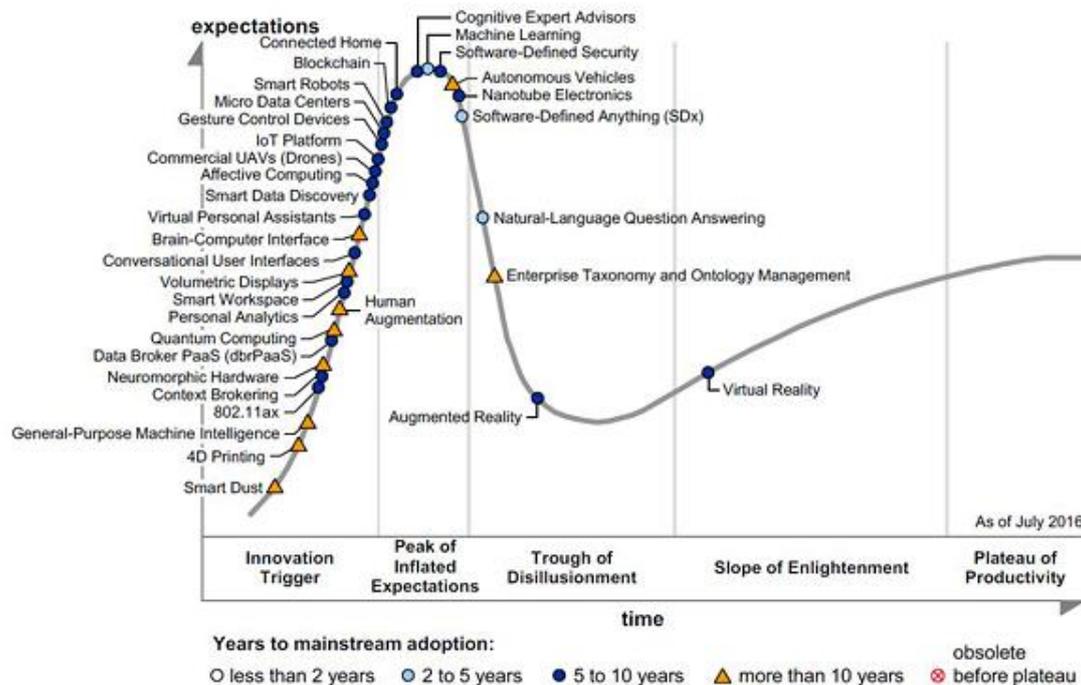


Figure 1: Hype Cycle for Emerging Technologies [1]

Blockchain as a concept of a distributed database was for the first time described by Nakamoto in 2008. He developed the concept of Bitcoin, a virtual currency based on encryption [2]. The concept behind Bitcoin is probably nowadays the most advanced blockchain application and the most discussed concept of blockchain technology in academia. But there are more ideas and concepts in other areas and in other industries. There are also concepts developed in the area of e-health. Often it seems that there is only an idea. There are also concepts developed in the area of e-health. Often it seems that there is only an idea. The most sophisticated approach seems to be MedRec prototype for electronic health records and medical research data by Ekblaw et al. 2016 [3], which bases on a paper about blockchain technology for medical data access and permission management [4]. Electronic health records (EHR) are a very sensitive area. Although, there exist HIPAA Privacy Rules and EU General Data Protection Regulation a lot of people don't trust EHR systems, especially in Germany [5]. [6]. Therefore, the idea is to begin with an application where a lot of structured data are automatically processed by several interest groups: the process of electronic prescription.

2. BACKGROUND

Many of the risks and concerns associated with EHR management can be mitigated with Blockchain. A blockchain is a distributed database system that keeps track of records [7], [8]. As records are added to the blockchain they are ordered in blocks and each block contains timestamp links to the related blocks. Blockchain records are secure and easily verifiable. As events or transactions that are captured as records occur, decentralized verification of their authenticity is carried out by majority consensus in networks [3].

Thus a blockchain is a sequence of data blocks where each data block consists of a data set and a hash value of the previous block (see Figure 2). These blocks are stored on each node of the network [9]. Data blocks are encrypted so that it is not possible to make changes later without changing all following nodes. Therefore, a blockchain can serve as "an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. The ledger itself can also be programmed to trigger transactions automatically [10]".

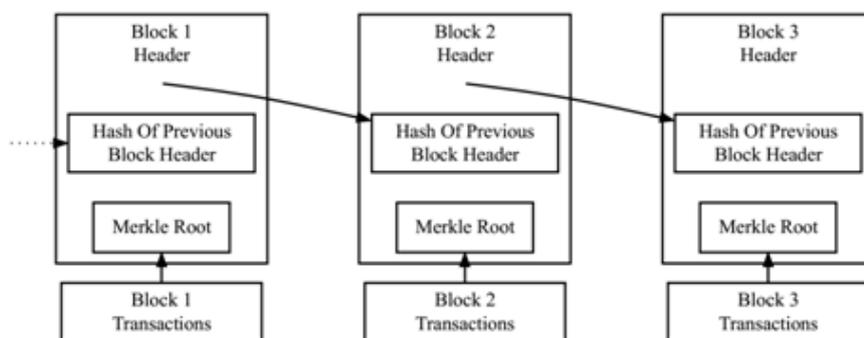


Figure 2: Blockchain [11]

Blockchains allow designing smart contracts: contracts between several parties. These contracts trigger defined actions [12], [13]. Thus, a record capturing an event becomes part of the blockchain if and only if significant effort is made by players in the network validating its genuineness and authenticity. Additionally, because network consensus is always required, alteration of records becomes very difficult and expensive. Hence, blockchain technology ensures that the effort required to alter a record (e.g., for the purpose of committing fraud, etc.) always exceeds the benefits or gains that result from attempts to alter the record. This reduces incentives of individuals or groups to change a blockchain record which indicates that what is in the blockchain is accurate and authentic [7].

As the blockchain is managed autonomously in peer-to-peer network information in it is not stored in a single location and is always available to use and verify and not susceptible to loss (e.g., because part of the network fails). Additionally, because verification and recording of information is carried out by the network, the need for intermediating role of trusted authority or

central server is significantly reduced, or depending on application, even eliminated [3].

Whilst in its purest form information in the blockchain is available to anyone, it is possible to create a blockchain where permissions concerning the right of individuals to add to, record in and read information on a block chain can be easily controlled. Private blockchains, as opposed to public blockchains, can be suitable tools for EHR management [14]

We contend that the benefits of blockchain technology should not be limited to EHR and have much potential in the area of electronic prescription.

3. ELECTRONIC PRESCRIPTIONS

Many countries have considered electronic prescriptions as a key component of their e-health solution. The electronic prescription, for example, was initially in step 2 of the implementation of the German electronic health card a compulsory administrative solution (see Figure 3).

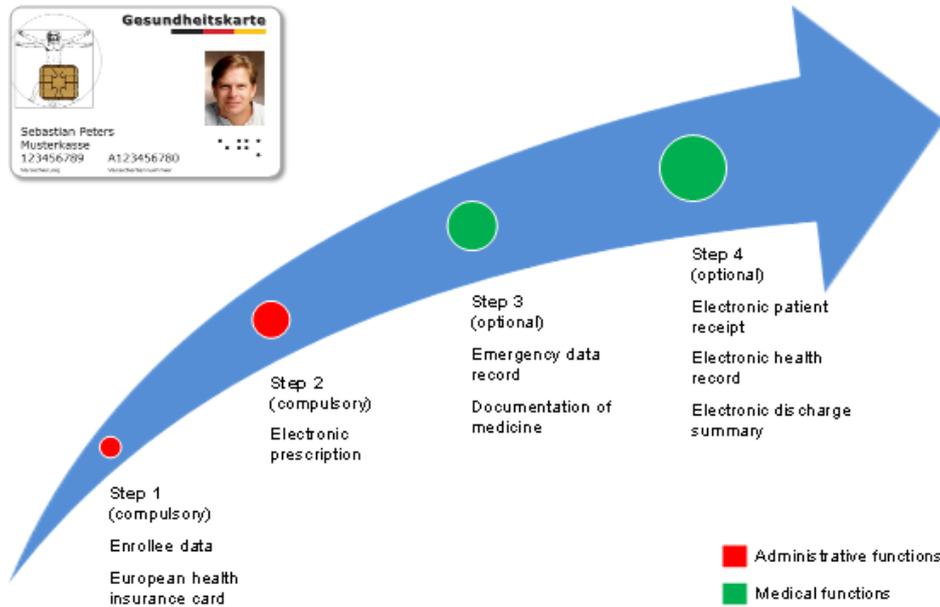


Figure 3: Initial implementation steps of the German electronic health card (adapted from [15])

This timeline was stopped in 2009 [16]. There were a lot of open questions with the telematics infrastructure and the concept. It was planned to store prescriptions in the storage on the card. But the size of the storage was small. The number of prescriptions was limited. It was also not possible to write electronic prescriptions during a visit at the patient's home. For writing prescriptions card readers and access to the telematics infrastructure was necessary. The idea of a total replacement of paper-based prescriptions by electronic prescriptions

was not possible. It was expected that round about 700 million paper-based prescription could be replaced every year [17]. The process of medication management (see Figure 4) is only a part of electronic prescription. The whole administration and clearance with insurance companies and other third party regulators is missing here. The process of electronic prescriptions concerns all parties of the web of healthcare players (see Figure 5).

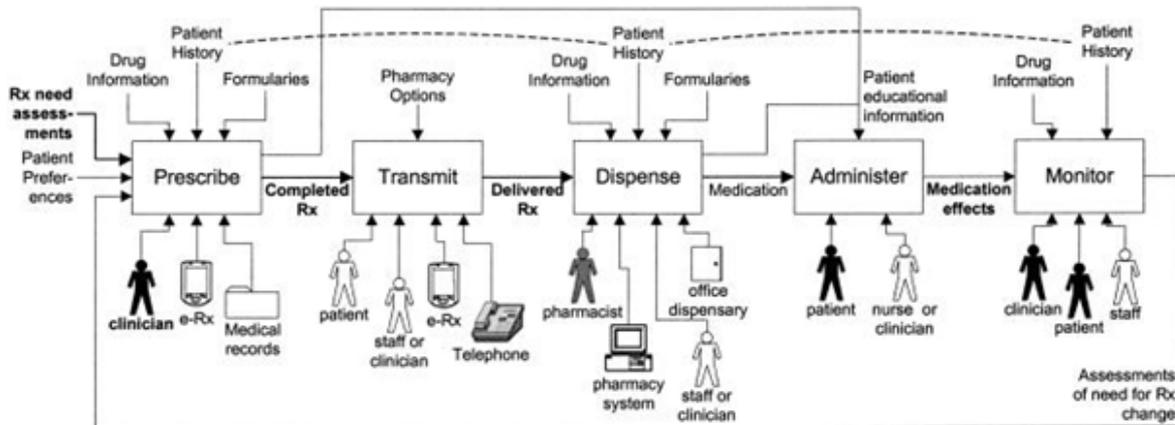


Figure 4: Process of medication management [18]

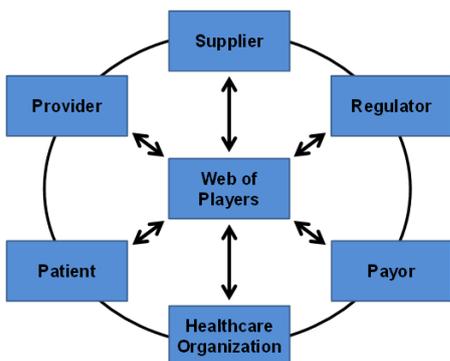


Figure 1: Web of healthcare players [19]

4. ELECTRONIC PRESCRIPTION BASED ON BLOCKCHAIN TECHNOLOGY

In the process of electronic prescription blockchain technology allows to design medication management as a smart contract. A medical doctor does not only prescribe medication he/she can also control and in some sense supervise the medication process remotely. A medication dispenser as an intelligent Internet of Things device can either remind the patient to take medicine to block overdoses and/or to report to the doctor patient's behavior. Smart contracts also allow taking care of regularly delivery, but also interruption of dispensation if

the patient or the insurance company doesn't pay. Also the whole clearing process can be automatized.

As long as the patient is able to take medicine physically by himself or herself blockchain technology and smart contracts can not only support the medication process, it can also automatize and help to control the process. For medium heavy diseases this also means less nursing staff especially as long as patients are able to live for their own at home.

5. DISCUSSION AND CONCLUSION

The objective of this paper was to proffer blockchain technology as suitable for assisting in electronic prescriptions to address current concerns and challenges. To date, as with the example of Germany most initiatives to implement electronic prescriptions have been met with significant opposition from either doctors and/or pharmacists for many valid concerns. We contend though that these legitimate concerns should not forestall the benefits of electronic prescriptions and thus a new approach and superior technology solution needs to be developed rather than totally abandoning the idea of electronic prescriptions as too difficult and too hard. Hence, we suggest the incorporation of blockchain technology.

From the theoretical perspective blockchain technology and smart contracts offer a large number of opportunities. However, from the perspective of practice, clearly there are still a lot of questions and unsolved problems regarding the use of blockchain technology for electronic prescriptions. This is only the technological perspective. There are also additional aspects and unsolved problems including critical issues around acceptance, barriers and ethics. To answer all these issues, we need further systematic research in this area. We are confident that such research will both enable successful electronic prescription to be possible as well as many other e-health opportunities so that patients can benefit from a higher quality of care delivery and at the same time healthcare can be delivered efficiently and effectively to all. Conversely, we believe that by ignoring the potential of blockchain technology for healthcare, we run the risk of never realizing the true potential of the myriad of e-health solutions currently being developed and implemented.

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