Socio-Technical Considerations for the Use of Blockchain Technology in Healthcare

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Abstract. Blockchain technology is often considered as the fourth industrial revolution that will change the world. The enthusiasm of the transformative nature of blockchain technology has infiltrated healthcare. Blockchain is often seen as the much needed and perfect technology for healthcare, addressing the difficult and complex issues of security and inter-operability. More importantly, the "value" and trust-based system can deliver automated action and response via its smart contract mechanism. Healthcare, however, is a complex system. Health information technology (HIT) so far, has not delivered its promise of transforming healthcare due to its complex socio-technical and context sensitive interaction. The introduction of blockchain technology will need to consider a whole range of socio-technical issues in order to improve the quality and safety of patient care. This paper presents a discussion on these socio-technical issues. More importantly, this paper argues that in order to achieve the best outcome from blockchain technology, there is a need to consider a clinical transformation from "information" to "value " and trust. This paper argues that urgent research is needed to address these socio-technical issues in order to facilitate best outcomes for blockchain in healthcare. These socio-technical issues must then be further evaluated by means of working prototypes in the medical domain in coming years.

Keywords. Blockchain technology, socio-technical, information communication technology, quality and safety in healthcare, disruptive innovation.

1. Introduction

Advances in biomedical science have dramatically improved treatment available for many diseases and thereby improved quality and longevity of lives among many of us. From the revolutionary chimeric antigen receptor T-cell treatment (CAR-T-cell) therapy to cure previously untreatable leukaemia [1] and direct anti-viral agent (DAA) to cure previously untreatable hepatitis C [2], to the promise of cell therapy and nanomedicine [3], many diseases that are considered incurable or untreatable half a century ago, is now treatable and potentially curable.

While the biomedical science revolution has changed what is available for patient care, this has not been matched with the improvement in the delivery process of healthcare. As such, patient's experience through healthcare journey continues to be problematic despite rapid advances in technology. In part, this is due to the fact that the current available information communication technology (ICT) does not seem to be able

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to deliver the perfectly matched solutions required to capture and deliver all necessary information to assist healthcare delivery in these complex health service environments.

This paper discusses challenges of currently technology in improving information communication within the healthcare sector. Next it discusses blockchain technology, especially the potentials of blockchain in improving information communication in healthcare. All new technologies, however, bring about the complexity of socio-technical issues that will impact on the outcomes of technological intervention. Blockchain technology is a revolutionary technology [4]. Hence, there is a need for a major clinical transformation to utilize the technology to the best outcome, which can be best scrutinized and discussed from a socio-technical perspective. As the technology starts to mature, we need to urgently consider the socio-technical challenges and solutions for blockchain technology to achieve best outcomes in healthcare.

2. Information communication technologies in healthcare

The lack of information or incorrect information at the time of patient care has been considered as the primary cause of problems in healthcare, leading to medical errors and adverse events [5]. Since the introduction of computer technology, many ICTs have been adopted by the healthcare sector, from computerised physician order entry [6] to full electronic health records [7]. More recently, ICT, such as Web 2.0 and the internet of things has been considered as a significant revolution that could change healthcare [8] by engaging patients to work with healthcare professionals and healthcare organisations.

ICT allows clinical information to be delivered faster, in many different forms, to be stored securely and to be utilised by different users simultaneously. The implementation of ICT has led to improved outcomes. However, the revolutionary effect of ICT in healthcare has not been realised [9]. Furthermore, ICT in healthcare faces significant challenges as it also has been associated with unintended consequences and work-arounds [10].

While many challenges and issues regarding ICT in healthcare are often considered to be socio-technical and socio-contextual issues [11], there are also technological problems that need to be considered. From a technological standpoint, current technology, such as the World Wide Web, Web 2.0 and mobile apps are based on TCP/IP platforms [12]. This is vulnerable to disruption, often with a lack of inter-operability and the unresolved question on ownership and actionable nature of information [12]. From a socio-technical perspective, there are issues with computer user-interface, user design and engagement. From a clinical transformation perspective, current ICT delivers information from one user to the other. While this process might promote sharing of information, sharing of understanding of the information is harder to achieve or measure. It is very important to understand the current information model for healthcare in order to discuss future healthcare care technological innovation.

Figure 1: Current information model for health care service

As demonstrated in Figure 1 above, while clinical information is entered and transmitted, the key player is the doctor making a possible diagnosis and using that as the main driving force (and main information transfer) for investigation and management.

The current available ICTs aim to transfer information from one party to the other. There is little discussion on agreement of information (do we all agree on the diagnosis) or action plan requirements (do we all agree that the treatment plan is useful). This information based healthcare model has significant implications if blockchain technology is to be used in healthcare.

3. Blockchain technology in healthcare

Blockchain technology promises to revolutionalise many industries [13]. The fundamental basis of blockchain is a radical concept based on a distributed ledger concept [14]. Each person in the chain agrees on the "value" that the person holds on the ledger [14]. The "value" is then stored by everyone within the chain [15]. The chain is updated in real-time for everyone, so that everyone gets the same information [14, 15]. The second important feature of blockchain is that blockchain allows smart contract. That automatically brings information into action when the pre-set criteria are met [16].

Proponents of blockchain consider this a revolutionary technology. Firstly, blockchain solves many current technological issues associated with technology implementation to improve communication in healthcare. Blockchain is stored as a distributed ledger and as such it is secure and hard to hack [14, 15]. Secondly, the data stored is "value" based and everyone agrees on this value, and therefore by definition it is inter-operable as the "value" of the information is stored simultaneously [14, 15]. Finally, blockchain allows smarts contract, therefore eliminating human judgment and errors. It also eliminates the need for acknowledgement and action from healthcare professionals, and as such, reduces delay in action [16].

As with any new technology, blockchain will have eager early adopters who consider blockchain as the technology that will solve many issues within the current healthcare system [17]. It is perhaps true that blockchain might bring radical changes to healthcare due to the nature of the technology. However, there are many socio-technical issues that need to be considered. The technology will take time to mature. During this early phase, encouragement of user-engagement and user-participation can help to identify and mitigate socio-technical issues that might affect the implementation of blockchain technology in healthcare. Importantly, the specific role that blockchain technology is best aligned to help needs to be considered. For instance, should we consider the use

of blockchain technology to manage a patient's whole health history or should we use it for only part of patient care, eg. in pathology or medication management.

Regardless of how blockchain will be used in healthcare, there is a fundamental shift from a socio-technical perspective that needs to be considered, especially considering the current healthcare information model as described in Figure 1. The fundamental challenge of blockchain is the need to consider the transformation from information to "value" of information which is the same for everyone within the chain. Blockchain requires a clinical contextual shift from information to value

Blockchain has generated significant interest in many industries. However, in many of these industries, blockchain might not require a fundamental transformation as there is often already an established "value" of information. In the banking sector for instance, the fundamental "value" of the information stored has already been agreed upon by the organisation and consumers. A particular person has a deposit which carries a monetary value which is agreed upon and other information is used to describe that value.

In healthcare, what is transmitted and what is used at present is information. From a patient's perspective, that information is their symptoms and what happens to them. When we measure improvement, we often take symptoms into account. From a doctor's perspective, a patient's symptoms are used to derive a diagnosis and a disease. The opinion of the doctor is imminent in the diagnosis and the disease, and seen as interpretation of the patient's symptoms. The diagnosis or disease, is not always correct, neither is it always fully acceptable by everyone, including the patients involved. Furthermore, laboratory tests come in a range, and normal and abnormal results are up for interpretation by the doctor. Finally, medical diseases often require medication treatment. Medications and dosages and what is required are often affected by individual opinions and interpretations. Medication management will be an ideal area for smart contract in blockchain to improve efficacy and reduce side effects. When certain criteria are met, the action will automatically be performed. We need to however consider safe-guard mechanisms to ensure safety.

When we consider the clinical context of healthcare, it becomes obvious that there are significant complexities in using blockchain in healthcare. These issues will obviously have significant impact on the usability of blockchain. It is very important that we start to consider and understand socio-technical issues and the use of blockchain technology in the context of healthcare before the technology becomes mature and is utitlised in healthcare. This paper suggests that urgent research into these socio-technical issues are needed for blockchain to be successfully adopted into healthcare.

Conceptually, blockchain technology will need a move from an information focus to a value and trust focus. Achieving complete information sharing in healthcare does not mean that we have complete understanding of the information for everyone within the chain. We need to consider how information can be utilised and transmitted in blockchain. This will not only be useful for everyone involved but also fully optimise the potential of blockchain. There needs to be substantial trust amongst everyone in the chain and understanding about the "value" of the information from various stakeholders. This will require a significant change in mind set and a cultural shift from within our current clinical practice. Given the need for the "value" of information, blockchain can well bring about the transformation that we need by focusing on the patient. It will hopefully allow for outcomes and improvement measures that focus on patients. While trust and value will allow for smart contract to be activated in blockchain, a patient's condition changes constantly and we need to consider the diagnosis as a dynamic process. As such,

safeguard measures must be put in place to terminate the smart contract before it is activated if the criteria no longer applies for the patient involved.

4. Conclusion

Blockchain is considered as the next industrial revolution. Blockchain appears to be a technology that will have the potential to transform healthcare. From a socio-technical and context perspective, blockchain requires a clinical transformation and a shift from information to value and trust. This will potentially shift the focus to patients. Urgent research is needed to consider socio-technical issues in the healthcare context in order to best utilise blockchain in healthcare. Safeguarding measures need to be considered in this technology that is likely to bring disruptive innovation to healthcare.

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