

Blockchains in Healthcare: Perspectives for the UK

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Intro

Blockchains are a trending topic of discussion these days. The Chief Scientific Advisor to the UK government Sir Mark Walport argues they can be used to make government departments more secureⁱ, the Bank of England Deputy Governor Ben Broadbent believes they can transform the way the bank conducts its activitiesⁱⁱ and The Economist claims it will transform the way the economy worksⁱⁱⁱ, the way finance will operate^{iv}, and the way randomised controlled trials are verified^v.

So what is it about Blockchain technology that makes it so disruptive, and how could it be applied to medical data and processes?

What is a Blockchain?

Just like the internet, Blockchain technology has many different layers and functions, and means different things to different people. Having first emerged as the underlying innovation powering Bitcoin, Blockchain technology is now growing up to power applications across all industries.

Fundamentally, it is a **computing infrastructure** with the following key characteristics^{vi}:

- It is a **distributed database**: all data on Blockchains is both administered by the network and distributed among the computers participating in the network. This means that rather than having a centralised actor running and controlling the database (and ensuring it does not get compromised and leaks everyone's data!), all participants in the network can use peer-to-peer communications to read and write on the Blockchain. This paradigm can provide cost, performance and security improvements over traditional databases.
- It is an **identity and permission management platform**: each user in the network holds the cryptographic keys to decrypt their data on the Blockchain, and may easily give permission to other users' (or applications) keys to be able to access their data. Having no central "single point of failure" which holds all data or all keys makes Blockchains more resilient to breaches.
- It is **programmable (and open source)**: although this isn't a characteristic of original bitcoin Blockchain, Blockchains can be made to store not only data, but also computer programs (called smart contracts). These programs can be triggered by other activities on the Blockchain, and are run in a completely decentralised way by all actors in the network. This can lead to big cost and resilience gains.

Current NHS data conundrums

The current healthcare data storage, collection, verification and retrieval processes in the UK are far from streamlined. Let's take a look at the journey a typical patient's data: the patient turns up at a provider (a hospital for example), activity is written up (on paper most of the time) by the doctor, who then ships the notes to coders^{vii} to input the data manually on their computer. The resulting datasets are stored on the hospital patient administration (PAS) system and submitted to SUS (secondary user system). The SUS data is then sent to the Health and social care information centre (HSCIC) who use it to generate Hospital Episode Statistics (HES)^{viii} data which is distributed by them and used by commissioners, providers or academics to write strategic reports, identify gaps in provision, benchmark design public policy or answer various research questions. All of these users have to undergo a lengthy application process before receiving a cut of the HES data.

A similar data journey happens throughout practices - primary care, mental health, pharmacy, dentistry, social care etc. - but each practice uses different systems which do not talk to each other. Additionally, this process does not cater for useful datasets produced outside this ecosystem: privately collected patient data coming from their smartphones and wearable devices, data from medical trials stored on academics computers, government research datasets, etc. This leads to data that is incomplete, inoperable, and stored in disparate places. This in turn leads to less effective decision making, too little or too much care^{ix}, and poorer health outcomes for patients.

Healthcare data impact

There are three ways a Blockchain future could improve the healthcare data landscape:

- 1) **Consistency and interoperability:** Using a shared Blockchain to store all medical data coming from each system, practice, and device can help ensure no two systems (across SUS, CCG, Trust etc.) have a different view of the patient record. This also ensures that data can be linked across different parts of the patient pathway - a critical hurdle for integrated care.
- 2) **Cost Savings & Easier Data Sharing:** Hospitals, Commissioners or Gvt. Agencies could save millions of pounds a year spent on Oracle or SAP systems by moving to potentially free & open source Blockchain tools, which leverage the network instead of requiring dedicated storage and computation power. With these tools, access can be easily granted (with patient consent) to any doctor, researcher, analytics system, or app needing to interact with the patient record. On top of this, simplifying the data sharing process lowers the barriers to entry for the next wave of analytics applications.
- 3) **Security & Empowerment:** Currently patient data is often inaccessible to the patient themselves and stored in centralised systems that may be compromised by a one-off breach. As new data such as genetic, sensor data, or fitness activity enter the picture, this becomes increasingly relevant. Giving the patient access to her own data and a key that allows them to decide who else should be able to access it for research or other purposes will increase security and empower the patient.

Health Blockchains in practice

In order to gain some understanding of how Blockchains can be used in the healthcare realm let us create an extreme scenario that paints a picture of a medical data world entirely governed by Blockchains:

Imagine Patient A - let's call her Lisa - who holds her and her family's historical medical record, produces live fitness activity and sensory data from wearable devices, and has her DNA sequenced by 23andme.^x What would her place be in a Blockchain enabled medical data world?

In a Blockchain-enabled world Lisa can:

- Grant read and write access to her data to **Care Providers** and **Third Party Applications**, who can provide superior and more cost-effective health outcomes by having fast access to the relevant data sets. For example her dosage reminders could be encoded into Smart Contracts (resulting in a simple push notification on her phone) and predictive diagnostics applications could alert her of issues before it's too late
- Have her data anonymously audited by **Government** or **Commissioners** for compliance, regulatory, and resource

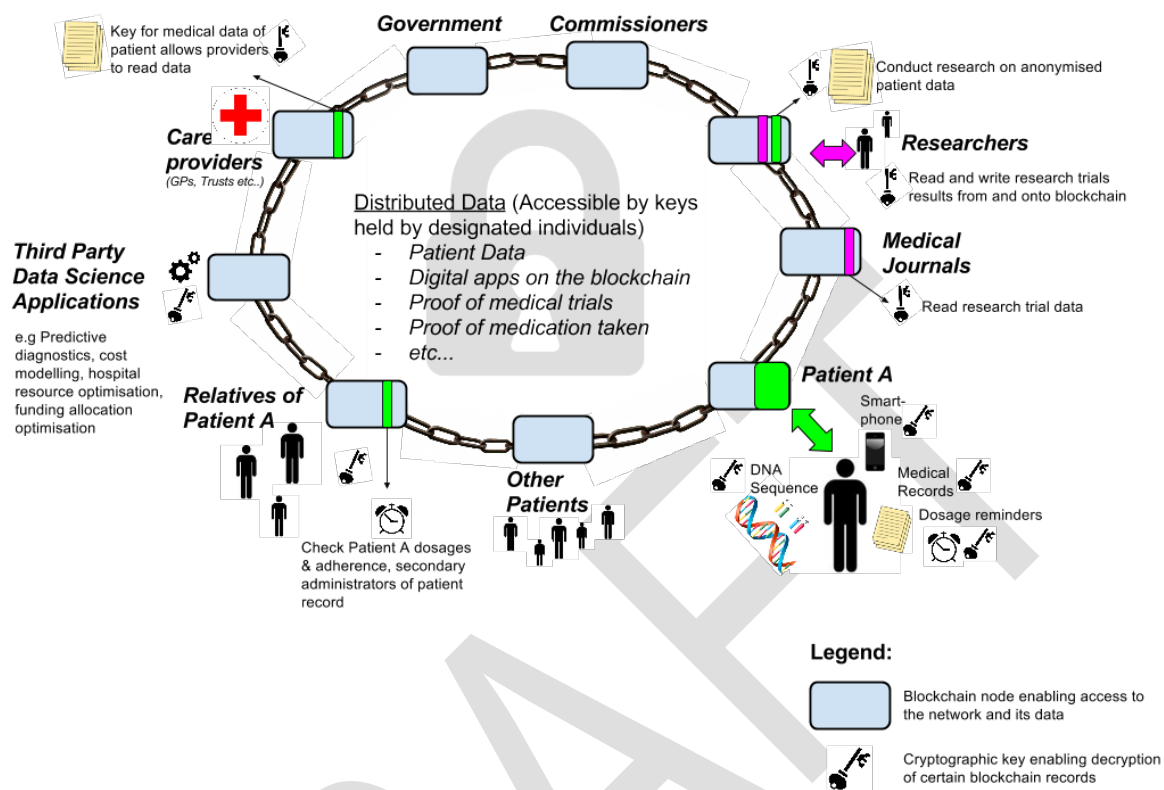
allocation optimisation. If a significant sample of patients opt in, these actors can have a better view of the market demand for certain types of care (by season, geography, patient genetic makeup, socio-economic status etc) and can better match supply.

- Contribute to **Medical Research** by providing her anonymised records, and in turn benefitting from the latest trials data and outcomes from leading **Medical Journals**
- Choose for her close family and/or friends to be able to administer her medical record and help her take health decisions. For instance she may choose to let her family see her adherence to medication (potentially captured through a Proteus "Smart Pill")^{xi} and get alerts if she has missed her medication

This theoretical world enables all authorised participants to have a shared view of Lisa's data and the tools to securely interact with her medical record.

Figure 1 on the next page shows how the Blockchain can help achieve this and how it might look like in its most developed form.

Figure 1:
The healthcare Blockchain - a look into the future?



Source: Own illustration

Conclusion

Digitized medical data can play an important part in improving health outcomes and reducing the cost of care, but today's infrastructure and processes leave us barely scratching the surface in terms of putting this data to use. They are expensive, inoperable between providers, don't give patients access to services, often inconsistent and while extremely secure by today's standards don't have the highest possible level of security as they are still subject to failure at discrete points. To effectively benefit from digitized medical records several challenges need to be solved. These include secure and consistent data sharing between systems, access and control for patients as well as scale and cost efficiency. These are complex problems that require subtle approaches. In this view

Blockchain technology allows us to look at these no longer as technical impossibilities but as operational challenges. This is already a significant step forward. At least it is now technically possible to solve some of these issues so even if Lisa's world might still be a far way away - conceptualising it in the way we tried to do above will help us think about new ways of tackling these issues.

Other countries have already recognised this and are leading the way. For example as part of its e-government system, the Estonian government have rolled out a Blockchain which is integrated into existing systems and already secures 1 million health records. This is exciting and points to a future in which data security, patient empowerment and healthcare analytics play a more prominent role in public life. Definitely worth paying attention to!

ⁱ <http://www.bbc.co.uk/news/technology-35344843>

ⁱⁱ <http://www.theguardian.com/money/2016/mar/02/bitcoin-digital-currency-britain-banks>

ⁱⁱⁱ <http://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine>

^{iv} <http://www.economist.com/news/finance-and-economics/21695068-distributed-ledgers-are-future-their-advent-will-be-slow-hype-springs>

^v <http://www.economist.com/news/science-and-technology/21699099-Blockchain-technology-could-improve-reliability-medical-trials-better>

^{vi} For a more complete picture of the Blockchain, we recommend this excellent [WSJ piece](#).

^{vii} “Coders” here refers to sophisticated data entry personnel who “encode” the activity of the hospital into reimbursable diagnosis and procedure codes. (To be precise: technically it is not the diagnosis and procedure codes which are reimbursed for. There is another step: The diagnosis and procedure codes feed into a computer software called the “ grouper” which turns the diagnosis and procedures into hrgcodes, which the hospital is then reimbursed for).

^{viii} <http://www.hscic.gov.uk/hesdata>

^{ix} See this great article on excessive care in the US <http://www.newyorker.com/magazine/2015/05/11/overkill-atul-gawande>

^x <https://www.23andme.com/en-gb/>

^{xi} <http://www.forbes.com/sites/singularity/2012/08/09/no-more-skipping-your-medicine-fda-approves-first-digital-pill/#35eecda35762>