Medical Records

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Healthcare and the Blockchain

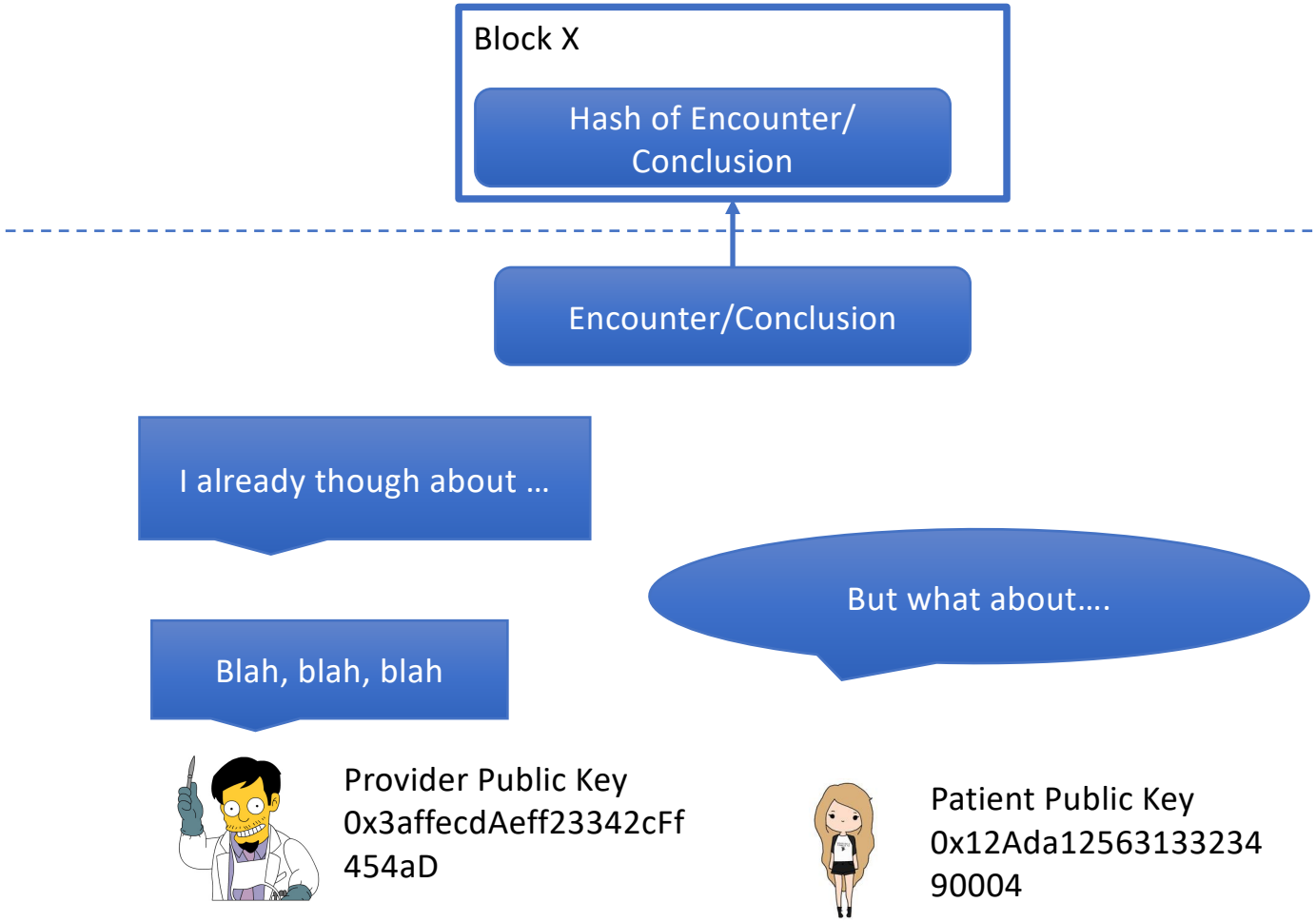
- Goals of Healthcare System
- Different Approaches
  - Similar to Bitcoin
  - Other Approaches
- Other Issues
  - Difference Healthcare Delivery Models
  - Universal Identifiers
  - Beyond the Web

Goals of Healthcare Information System

- Provide Rapid Access to Relevant Information About a Patient
  - Single location?
  - Interoperability
- Ensure Security of Patient's Healthcare Information
  - How much information should be available?
    - Preexisting conditions
  - How much information should not be available?
    - Medical Billing Fraud
- Ensure Quality of Healthcare Delivery
- Provide Access to Medical Information for Research

Impediments to Healthcare Information System

- Medical Records are Decentralized
- EMR Systems are not Interoperable
- Patient and Providers Goals are not necessarily similar


Block X
Hash of Encounter/ Conclusion
Encounter/Conclusion
I already though about …
But what about….
Blah, blah, blah
Provider Public Key
0x3affecdAeff23342cFf
454aD
Patient Public Key
0x12Ada12563133234
90004

HealthCare Blocks

- What goes into a consultation?
  - Conversation?
  - Equipment?
  - Start and Stop Time?
  - Procedural versus Declarative
    - You have Squamish cell lesion versus I looked at the top of the lesion and then looked at the margin ……
- What goes into a consultation chain?
  - All previous consultations with different pairs of patient and provider?

Block X

Block X

Block X

Block X

Block X

Block X

Block X

Block X

Block X

Block X

Block X

Block X+1

Block X

Block X+1

Block X

Block X+1

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Block X

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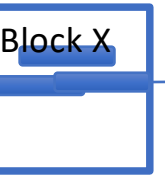
Block X

Block X+1



Block X

Block X+1

Block X

Block X+1

Block X

Block X+1

Block X

Block X+1

HealthCare Chains

- Solves the issue of availability
  - Every node has a complete record
- Increases size of each node
- Unclear what would be the benefits of mining

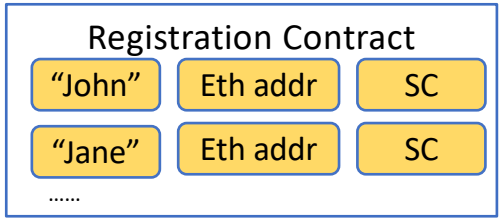
Tokenization of Agents

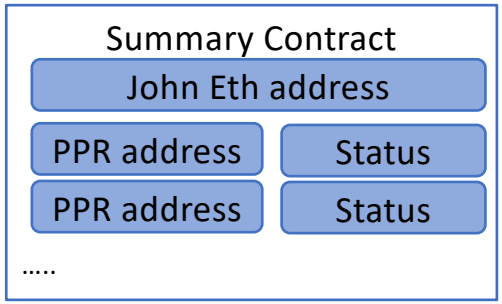
Agent Types

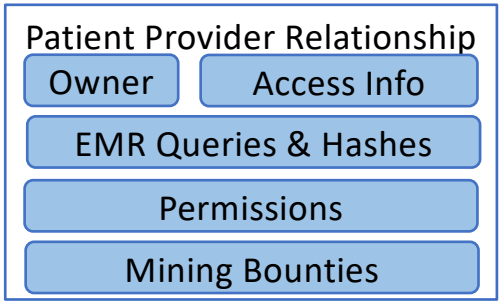
- Person as an aggregation of digital identities
  - Medical
  - Financial
  - Academic
  - Social Media
  - ….
- Person is an aggregation of person's digital identities
- Should/How will a medical record system interface with other identities
- Rather than a single uPort key the registry keeps a hash of all identities so Information_return (medkey, uPort) returns the medical information but does not provide access to financial
- Organization (hospital) is an aggregation of digital identities of it's components
- Information (hospital.doctors, uPort) returns identities of doctors at hospital
  - Information (academicKey, hospital.doctors) returns credentials of doctors
- Information_return(BP,uPort) could return information on the company such that Information_return((Token_name(_component)),uPort) could return information on the company that made the device used in a particular medical procedure

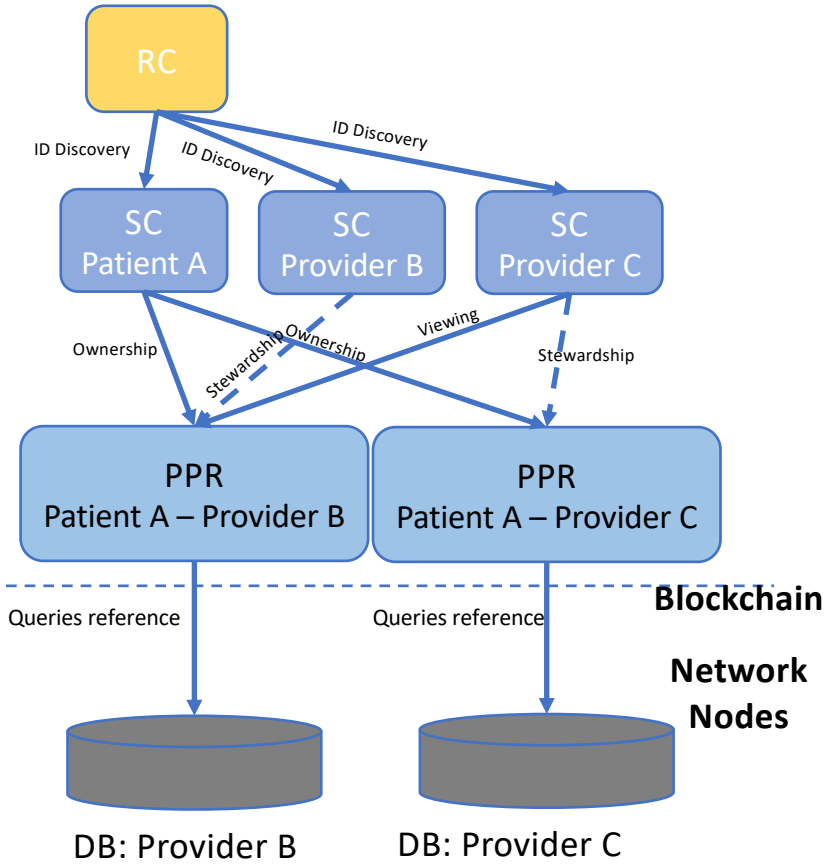
Juels, A. (2016). Reassembling Our Digital Selves. *Daedalus, 145*(1), 45-53.
Lundkvist, C., Heck, R., Torstensson, J., Mitton, Z., & Sena, M. (2016). *UPORT: A Platform for Self-Sovereign Identity (Draft Version 2016-10-20).* NY: Consensys.

HealthCare Permission Chains









Azaria, Ekblaw, Vieira, & Lippman 2016 , Med:Rec…..

HealthCare Permission Chains

- Reduces the data on the chain to only permissions
- Record of pointers to all relevant records
  - Facilitates creation of patient chart/record
- Still Decentralizes records
- Can this support the ACO?
- Might interface with all identities (ID2020) https://id2020.org/
- Interplanetary File Systems https://ipfs.io/#why

Distributed Ledger Technology for Secure and Sharable Electronic Medical Records

Pros and cons

Research Question

- Whether distributed ledger technology, with its intriguing approaches to the security of sensitive data and its potential for secure distributed implantations, will be a compelling alternative for healthcare professionals who are currently faced with security and distribution issues in their current electronic medical records implementations

Research method

- Case study analysis
  - Interviews with U.S. health system Chief Information Officers and Chief Technology Officers
  - Regulatory insights from the office of the Secretary of the Department of Health for a Southern U.S. state
  - In-depth interviews among a group of ten knowledgeable executives and academics on the nature of Blockchain itself.

The Regulators are [cautiously] on board…

- State Department of Health spokesperson noted:

  Healthcare providers all believe that transparency in healthcare is crucial and important, and it helps providers do a better job when they can see records that follow the patient, and it helps patients with their outcomes and it helps patients be more clear about their wishes for care in the long run. We support that, we just want to do it the right way. (State Secretary of Health Office)

The value of secure transferability of records is clear to providers:

- Health System Chief Information Officer:

> *Just think of the transitions of care. You go from a physical clinic, to an emergency room, then you might go to a nursing home. And in all of those are transitions of care [providers]are going to want to know allergies, medications they are on, blood work, X-rays, etc., so it's a really big deal.*

Securing health information

- There are problems with conventional electronic medical records and the information systems upon which they reside - notably with regard to privacy and security. [1]
- Storage and transfer of EMR have not achieved strong consensus in the healthcare industry, though the orthodox HIE implementations of centralized storage and bulk file transfer have largely been deemed inadequate for security purposes. [2]

1) D. Ivan, “Moving Toward A Blockchain-Based Method for the Secure Storage of Patient Records,” in ONC/NIST Use of Blockchain for Healthcare and Research Workshop. Gaithersburg, MD, 2016.
2) L. Peterson, R. Deeduvanu, P. Kanjamala, and K. Boles, “A Blockchain-Based Approach to Health Information Exchange Networks,” NIST Workshop on Blockchain Healthcare, 2016, pp. 1-10.

The Interoperability problem

- …equally difficult and risky to achieve in current EMR implementations and solutions. [1]

Chief Technology Officer:

We don't have good interoperability today, and the current health IT model does not have an easy place for Blockchain to fit in. There has to be a whole lot of work done with the APIs and such before we're ready for that.

1) L. Peterson, R. Deeduvanu, P. Kanjamala, and K. Boles, “A Blockchain-Based Approach to Health Information Exchange Networks,” NIST Workshop on Blockchain Healthcare, 2016, pp. 1-10

The interoperability problem

- Patients move around a lot; it is what people do in their lives, largely, and when they move they need to take their medical history with them in order to support effective healthcare delivery with their new providers. [1]
- The problematic issue, since patient records are generally electronic, is how the records can be securely and effectively shared across providers in order to follow patients as their lives take them to new treatment locations. [2]

1) A. Dubovitskaya, X. Zhigang, S. Ryu, M. Schumacher, and F. Wang, "Secure and Trustable Electronic Medical Records Sharing using Blockchain," https://www.researchgate.net/profile/Alevtina_Dubovitskaya/
2) D. Ivan, "Moving Toward A Blockchain-Based Method for the Secure Storage of Patient Records," in ONC/NIST Use of Blockchain for Healthcare and Research Workshop. Gaithersburg, MD, 2016.

The interoperability problem

- *It's one of those Catch 22's: we need to share the data, but you can't risk having it get out to the wrong parties. It's a fine line. That security aspect is huge for us, I can't overstate that. (Health Provider Corporation CIO)*
- *[Security problems] really start with what the current governance issues are [with the current systems]. Who controls the data, where is the data living, how do you aggregate the data, and the whole interoperability question, which we still don't have a good answer for. It's that whole process of data governance. (Health Provider Corporation CTO)*

Old school sharing mechanisms for EMR

- *…most of the time it's on DVD. We burn the records to a disc. I could see how, with the computer, we could share that record with the particular patient. I think there's value in that. But, how do you secure the share of that stuff? (Healthcare Corporation CTO)*
- Or, fax…

The health information exchange (HIE)

- The HIE mechanisms are usually set up on the basis of electronic record keeping systems managed by one of several leading EMR providers (the underlying EMR storage system serving as the basis for the inter-firm sharing arrangement of the nascent HIE). In our discussions with healthcare providers in the Southern United States, the sense was that two specific companies generally lead the EMR/HIE market:
  - Epic Systems of Verona, Wisconsin
  - Cerner Corporation of North Kansas City, Missouri.

Blockchain as HIE replacement?

- *Really, Blockchain to me is just a better way for HIEs to operate. (Healthcare Corporation CIO)*
- *I think that anything that increases interoperability and access to information securely between providers, they would be all for it. (State Secretary of Health Office)*

Prevailing industry views; blockchain for EMR/HIE

- Notwithstanding, the authenticity of data on distributed ledgers is a very attractive feature for healthcare providers considering EMR Blockchain implementations:
  - *A medical record is worth more on the black market than a credit card. (Healthcare Corporation CIO)*
  - *If there's a method that gives us one hundred percent surety [about the source of the data] then that would be even better, because clinicians still have a legal risk when they rely upon data and if they don't feel comfortable and can't trust the data, we have a problem. (Healthcare Corporation CTO)*

Prevailing industry views; blockchain for EMR/HIE

- From the view point of scholars as well as industry executives, the issue of trusted third parties for managing access credentialing is a point of concern for future Blockchain implementations in healthcare:
  - *Part of the idea of Blockchain is that there's one individual who has authority over the data, and that person holds the private encryption key. In order to see the data you have to have that key, they give permission to others to see that data. That's one of the things that has to be worked out, too, how do you get that trusted authority. How do you decide who holds the key. (Healthcare Corporation CTO)*

Prevailing industry views; blockchain for EMR/HIE

- *Who owns it? Somebody has to be the gatekeeper. Who is there to ensure that there is integrity with the systems. Who's going to regulate these different groups? (Healthcare Provider CIO)*
- *You almost have to have a national presence, like social security, a national patient identifier. That's where it gets complicated. It gets risky when you start doing some of that because of the patient registration issue. I don't think we're quite where we need to be. (Health Insurance Provider CIO)*

Data integrity vs. access control

- *So the promise of Blockchain is that it should provide one hundred percent authenticity of where the data came from, and then track every step of the way, where it's seen, who's looked at it, did they do anything to it, and where its being routed to. That's the promise of Blockchain, but we have our current ecosystem which doesn't have interoperability. The standards have not been standardized, and where you put Blockchain in that is a challenge. I think there's a lot of hope and promise and hype about Blockchain, but we just beginning to go down the path with it. (Healthcare Corporation CTO)*

Safe but not impregnable

- Yes; Blockchains are encrypted.
- No; encryption is not fool proof. It is considered “expensive” but not impossible to crack Blockchain’s encryption. [1]
- It takes time and resources to do so, but public Blockchains using a proof-of-work consensus algorithm are not absolutely impregnable given the will and the capability of something on the order of a rogue state actor to decrypt.

1) V. Alcazar, “Data You can Trust: Blockchain technology,” Air & Space Power Journal 31(2), 2017, pp. 91-102

Buzz and practicality

- *For ourselves, at this moment, it's probably not worth a lot of our time to do the research on the process. But that's just for right now… I could see how, with the computer, we could share that record with the particular patient. I think there's value in that. But, how do you secure the sharing of that stuff? (Health Provider CTO)*
- *[Blockchain] is currently the hot buzzword. There's been discussion here about it. How we could use [it]. I personally think there's something there. But I think it's [far away] from being realized. (Health Provider CIO)*

A degree of regulator ambivalence, despite merit

- *It's fallen on our radar rather than being there on its merits. We're always interested in interoperability of Electronic Medical Records. From my perspective, I sort of see more complications with Blockchain than immediate benefits, though. (State Department of Health Office)*
- Regulators were interested in the Blockchain solution for purposes of protected network provision of EMR. Encrypted storage and authorized access was their desire.
- Blockchain can do that.

A degree of industry ambivalence as well

- *We haven't found the perfect solution yet. From the broad technology perspective, [Blockchain] makes sense, but like anything, until we get it out there in the real world and have the opportunity to experience it, we won't know. (Health Provider CTO)*
- *It's a relatively new methodology, as with any new methodology, is it truly foolproof? Think about some of what you hear about Bitcoin, if you lose your private key, can you recover your data? We don't know how it's going to work until we get some large scale trials going on. (Health Provider CTO)*

Overview, in summary

- We used exploratory in-depth interviews with healthcare professionals and governmental officials to identify prevailing needs as well as current perceptions of Blockchain technology.
- We were able to identify the most important factors which determine the recording, storage and retrieval of health-related information and contrasted those with the basic functionality of Blockchain.
- Currently it is too early to reach a final judgement about the applicability of Blockchain in the healthcare sector, but we hope that this exposition helps to lay the foundation for further informed inquiry.