Blockchain: The Future of Healthcare Data?

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Centre for Cryptocurrency Research and Engineering
Imperial College London
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Distributed Ledgers: The Future of Healthcare Data?

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Meet the Team

Will Knottenbelt
Professor of Applied Quant. Analysis

Cathy Mulligan
Smart Cities Telecoms Government Advisor

Rob Learney
Bioengineering Future of Medicine

Melek Somai
Public Health Digital Transformation

Iain Stewart
Mathematics of Security & Scaling
Triple Aims of Healthcare

Experience of Care

Per Capita Costs ↔ Population Health

DM Berwick, 2008. Health Affairs
Core Elements

- Patient Involvement
- Local Population Needs
- Emphasis on Prevention
- Financial Management
- Macro-System Integration

DM Berwick, 2008. Health Affairs
How to Connect the Dots?
The ‘Integrator’

- Patient Involvement
- Local Population Needs
- Emphasis on Prevention
- Financial Management
- Macro-System Integration
Patient Involvement
Local Population Needs
Emphasis on Prevention
Financial Management
Macro-System Integration
The ‘Integrator’

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- Macro-System Integration
The ‘Integrator’

- Patient Involvement
- Local Population Needs
- Emphasis on Prevention
- Financial Management
- Macro-System Integration
The Future of Healthcare is Data
All Driven By Data

- Patient Involvement
- Local Population Needs
- Emphasis on Prevention
- Financial Management
- Macro-System Integration
Imagine: Healthcare in 2027

- Tony
- 26
- Married
- 1 Young Child
- Works at a Supermarket
Imagine: Healthcare in 2027

- Tony
- 26
- Married
- 1 Young Child
- Works at a Supermarket
- Severe Asthma
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Tony’s Healthcare Journey
Millions of Tonys
Millions of Journeys
Map 23: Rate of asthma emergency admissions to hospital in people aged 19 years and over per population by CCG

Directly standardised rate, adjusted for age and sex, 2012/13

Domain 2: Enhancing quality of life for people with long-term conditions
Domain 3: Helping people to recover from episodes of ill health or following injury

Artificial Intelligences / Expert Systems

Healthcare Records

Devices & Software
Artificial Intelligences / Expert Systems

Healthcare Records

Devices & Software
Roadblocks to Progress

• Identity Management System
• Secure Data Storage
• Secure Backup System
• Legal Compliance

• Data Formats
• Communication Protocols
• APIs

Repetition & Reinvention

Opaque/Absent Standards
Roadblocks to Progress

• Identity Management System
• Secure Data Storage
• Secure Backup System
• Legal Compliance
• Data Formats
• Communication Protocols
• APIs

Repetition & Reinvention

Opaque/Absent Standards
# N-Squared Problem of APIs

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Monopoly Pressures
Wearable devices that track fitness are a rich source of real-time health data.

Stop the privatization of health data

Tech giants moving into health may widen inequalities and harm research, unless people can access and share their data, warn John T. Wilbanks and Eric J. Topol.
Permissionless Innovation

- NHS
- New Companies
- Established Companies
- Patients
What is Distributed Ledger Technology?
<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
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<tr>
<td>Jan 25</td>
<td>To sundries</td>
<td>10 1/6</td>
</tr>
<tr>
<td>Mar 19</td>
<td>Making 11 dozen</td>
<td>2 9/10</td>
</tr>
<tr>
<td>Mar 23</td>
<td>Washing &amp; pitching</td>
<td>2 1/2</td>
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<tr>
<td>Mar 27</td>
<td>Making 1 dozen</td>
<td>1 1/2</td>
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<tr>
<td>Apr 1</td>
<td>Taking &amp; Market 2</td>
<td>3 3/4</td>
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<tr>
<td>May 3</td>
<td>Hauling 11 dozen</td>
<td>3 3/4</td>
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<tr>
<td>May 27</td>
<td>To sundries</td>
<td>1 8/12</td>
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<tr>
<td>June 12</td>
<td>Making 11 dozen</td>
<td>6 1/2</td>
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<tr>
<td>Aug 23</td>
<td>Selling 10 dozen</td>
<td>2 1/2</td>
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<tr>
<td>Oct 12</td>
<td>Selling 10 dozen</td>
<td>1 1/2</td>
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<td>Feb 1</td>
<td>Selling 10 dozen</td>
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<td>Mar 3</td>
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<td>Oct 12</td>
<td>Selling 10 dozen</td>
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<tr>
<td>Nov 12</td>
<td>Selling 10 dozen</td>
<td>1 1/2</td>
</tr>
<tr>
<td>Dec 12</td>
<td>Selling 10 dozen</td>
<td>1 1/2</td>
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This account settled, all and sundry.

To find due two dollars fifty.

John Durham, May 27th, 1817.

Christina Stoddard.
Key Features of DLT:
- High availability
- Synchronised records
- Secure against intrusion
  - Cryptographic keys
- Impossible to alter history
Core Components

- P2P Message Passing
- Consensus Mechanism
- Cryptographic Signatures
- Distributed Copies

DLT
DLT vs. Blockchain
DLT

Permissions

Closed Group

Traditional Systems

PAXOS

PBFT

New Systems

Hyperledger

Bitcoin

Ethereum

Open Group

Blockchains

Tangles

IOTA
One Possible System
A Patient Chain
In Conclusion
DLT in Healthcare

• Continuously available distributed records
• Access controlled by cryptographic keys
• Audit trail embedded into system
• Unable to edit history
• Standardised message passing
• Permissionless innovation
Thank You

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