Role of Blockchain in Precision Medicine: Challenges, Opportunities, and Solutions
Global Healthcare Crisis

- **40 of the 56 million annual deaths** globally occur from preventable chronic conditions such as cardiovascular disease, cancer, and chronic respiratory conditions.
- **80% of all heart disease, diabetes, and stroke** and **40% of cancers** can be prevented by optimizing risk factors including **obesity, hypertension, sedentary activities, poor nutrition, tobacco, and alcohol use**.

- **Global aging** and an **expanding middle class** are a major contributor to the chronic disease epidemic.
- **10,000 Americans turning 65 everyday**.
- **80% of Medicare costs** are accounted for **20% of the patients**, who are **elderly**, with **multiple comorbidities** such as diabetes, COPD, or congestive heart failure.

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**US Healthcare Costs**

- **2007**: $2.298 trillion
- **2012**: $2.807 trillion
- **2017**: $3.660 trillion
- **2022**: $5.009 trillion

16.4% 17.9% 18.4% 19.9%

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*CMS—National Health Expenditure Projections 2012-2022 / Lancet Global Burden of Disease 2015 / World Health Organization / CDC*
Precision Medicine—A Major Big Data Challenge

Precision Health will see a $140+ billion market opportunity by 2025

Key Data Types/Factors

- Omics/Dx
  - 30%
  - Avg. per Patient Lifetime Data Volume (in TB): 6.0

- Clinical
  - 15%
  - Avg. per Patient Lifetime Data Volume (in TB): 0.4

- Remote Care
  - 20%
  - Avg. per Patient Lifetime Data Volume (in TB): 220.0

- Exogenous
  - 35%
  - Avg. per Patient Lifetime Data Volume (in TB): 880.0

The American Library of Congress has 15 Terabytes (TB) of data in total.

Data explosion along the care cycle globally to generate $4x10^{10}$ TB by 2020.

Source: IBM Watson Health; Frost & Sullivan Analysis
Precision Medicine—Inherent Challenges

- Healthcare data is worth **10x the price** of credit card data in the black market
- US Hospital Cybersecurity market alone is expected to cross the **$5 billion** mark by 2021

**Health Data Interoperability**
- Cost **150,000 lives and $18.6 billion** per year
- **About 46%** of US clinicians do not have a complete view of their patients’ health history/records

**Cybersecurity**
- **About 53% of patients** in the US believe that they own their healthcare data; **20%** simply do not know
- The global Healthcare Big Data and Analytics market will amount to **$7.50 billion** by 2020

**Value-based Care/Reimbursement**
- **About 90% top-selling** blockbuster medicines only work for **30–50%** of the patients
- **5–10%** of healthcare costs are fraudulent (e.g. excessive billing and/or billing for non-performed services)

**Data Ownership and Incentivizing Models**
- **About 70%** of consumers in the US track their health symptoms. **74%** appreciate receiving customized alerts/news feeds post care
- **41% of patients** will change their physicians if they are not allowed to access their health records

**Healthcare Consumerism and ‘Quantified-Self’**
- **About 53% of patients** in the US believe that they own their healthcare data; **20%** simply do not know

Source: Frost & Sullivan Analysis
Role of Blockchain in Precision Medicine Practice
What is Blockchain?

There are many definitions, with the evolving application potential of blockchain technologies.

Despite all the hype, for many people (across different industries), the blockchain concept still seems difficult to grasp, which makes it one of the most misunderstood technologies of 2017.

Frost & Sullivan’s Definition:

A blockchain is a new data structure that creates trusted, distributed digital ledgers for assets and other data. It is an immutable and time stamped record of digital events shared peer to peer between different parties. It can only be updated by consensus of a majority of the participants in the system and, once entered, information is very hard to erase.

Source: Frost & Sullivan
Blockchain is a type of distributed/decentralized ledger/database used to record digital transactions.

Properties of Blockchain Technology

- **Decentralized**: Network of replicated databases, synchronized through the Internet and visible to users/miners within the network.
- **Peer-to-Peer Network**: Transactions that satisfy certain conditions are recorded, eliminating a central administrator or third-party intermediaries.
- **Cryptographically Secured**: Transactions added to the blockchain are irrevocable or immutable.
- **Trusted**: Network requires consensus, which allows for transactions to occur between unknown parties.
- **Automated**: Avoids double counting and allows transactions to occur automatically.
How Blockchain Works
Understanding its core properties and differential value propositions

Define the Transaction
- User A wants to send money/data/asset to User B

Authentication
- The Block is shared among all parties in the network (e.g. Bitcoin)

Block Chaining
- The new ‘Block’ is added to the Chain, creating an immutable and timestamped record of the transaction

Create Blocks
- Network participants approve the transaction and render it valid

Transaction Fulfilment
- The ownership of money/data/asset is transferred from User A to B

Properties of Blockchain Technology
- Peer-to-Peer Network
- Decentralized
- Cryptographically Secured
- Trusted
- Automated

Source: Frost & Sullivan
6 Big Themes in Healthcare Industry and Role of Blockchain Technology

Is Blockchain the Missing Puzzle in the Healthcare Industry’s Digital Transformation Journey?

- Health Data Interoperability
- Cybersecurity
- Incentivizing/Monetizing Digital Health Business Models
- Healthcare Consumerism
- Value-based Care/Reimbursement
- Personalized Health and Precision Medicine Practice

Source: Frost & Sullivan
Blockchain Adoption Timeline by Major Healthcare Application/Use Case, Global

Immediate
- National Medical/Health Records
- Claims Adjudication, RCM & Billing Management
- Drug Supply Chain & Smart Contracts
- Digital Identity Verification/Management

Mid-term Future
- IoMT (Medical Device and Patient-generated Data Exchange)
- Clinical Trials Records & eConsenting
- Health Token (HSN, Research, Wellness Incentives)

Long-term Future
- Universal Health Records and Identities
- Regulatory Audit Trails & Adverse Event Safety Monitoring
- Drug Supply Chain & Smart Contracts
- Clinical Trials Records & eConsenting
- Health Token (HSN, Research, Wellness Incentives)
- IoMT (Medical Device and Patient-generated Data Exchange)

Source: Frost & Sullivan
Blockchain Implementation Challenges in Healthcare

- Nascent technology–Healthcare industry inertia
- Standardization–Healthcare terminologies/codes; semantic integrity
- Scalability challenges–Technology/Economic
- Threat of substitute–Emerging DLTs (IOTA, Graph DB)
- Connected-only mode–Requires network/Offline use cases?
- Negative news–Bitcoin as ransom money

Source: Frost & Sullivan Analysis
<table>
<thead>
<tr>
<th>Who are the users?</th>
<th>What use cases they can leverage now vs. next 5 yrs?</th>
<th>What are the key deployment/implementation challenges to consider?</th>
<th>What they would gain post implementation (ROI)?</th>
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<tbody>
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<td>Healthcare Systems</td>
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Note: The above framework is a strategic model developed by Frost & Sullivan to help healthcare industry stakeholders identify the most relevant blockchain use cases and the strategic imperatives for successful implementation.

Source: Frost & Sullivan Analysis
Future Prospective–Role of Blockchain in a Connected Health Ecosystem

**Patient Generated Data**
- Health Apps
- Implants
- Home Medical Devices
- Wearable
- Peripherals
- Activity Monitoring

**Clinical Data and Health Records**
- Hand-held Medical Tech
- Hospital Medical Devices
- Lab on a Chip
- Smart OR Devices
- EHR/EMR
- Ambulatory Med Devices

**Data Lakes**
- Off-chain storage
  - Stores different types of health data (e.g., images, genomics, and lab reports)

**Blockchain**
- Patient’s unique identifier
- Cryptographically secure
- Time stamped
- Patient can control whom to give permission to share data

**Health Analytics & IoMT**
- Providers use health application to access health data
- Patients use mobile devices to assign access permission to data and provide public key

**Automate claim adjudication and payment processing with predefined smart contracts**

**Off-chain storage**
- Providers use health application to access health data

**Distributed patient consent for research/clinical trials enables data sharing, audit trials, and clinical safety analyses**

Source: Frost & Sullivan
Related Research and Thought Leadership

- Complimentary Frost Prospective:
  - Why Healthcare Industry Should Care About Blockchain?
  - Top 5 Reasons Why Every Healthcare Company Should Invest in Blockchain
- Listen to this Webinar now on-demand: Healthcare’s Challenges and Blockchain - A Promising But Bumpy Ride!
- Recent Research Study:
  - Blockchain Technology in Global Healthcare, 2017–2025

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