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The Role of Blockchain Technology in Our Health Care Delivery System

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The U.S. health care system primarily consists of three entities: provider systems that deliver health services, patients who receive these services and payers (health plans and the government) that pay for these services. Each of these entities has its own unique challenges and their business objectives often conflict, leading to suboptimal outcomes. While patients grapple with affordability, access and fragmentation of care, providers are hard-pressed to seek improvements in resource efficiency and to address the causes of medical errors. At the same time, payers are constantly battling overutilization of services and increasing medical trends. Many of the challenges faced by patients, payers and providers commonly point to the need for a patient-centric model.

Over the last decade, our government agencies have encouraged a wider role for the providers in which their responsibility for patient health extends beyond the confines of their facilities to other downstream health systems rendering care. We see this play out in the Medicare Shared Savings Program models (MSSPs) and alternative payment models (APMs) and under the provisions of the Merit-Based Incentive Payment System (MIPS).

The Office of the National Coordinator for Health Information Technology (ONC) has laid out an interoperability road map[1] for achieving a "learning health system that promotes a patient-centric model where providers have a seamless ability to securely access and use health information from different sources." While big changes to interoperability are expected in the coming decade, as of now, patient electronic health records (EHRs) are not easily shared across all of the providers that are part of the care continuum, as they are typically tethered to the site of their origin.

The goal of this article is to encourage actuaries and other stakeholders to seek information and knowledge on an emerging technology called blockchain, which has the potential to radically change the way health care is delivered and administered. In this article, we will describe how a blockchain system works through a hypothetical example, discuss how this technology functions and explore the implications to actuarial endeavors in the future.

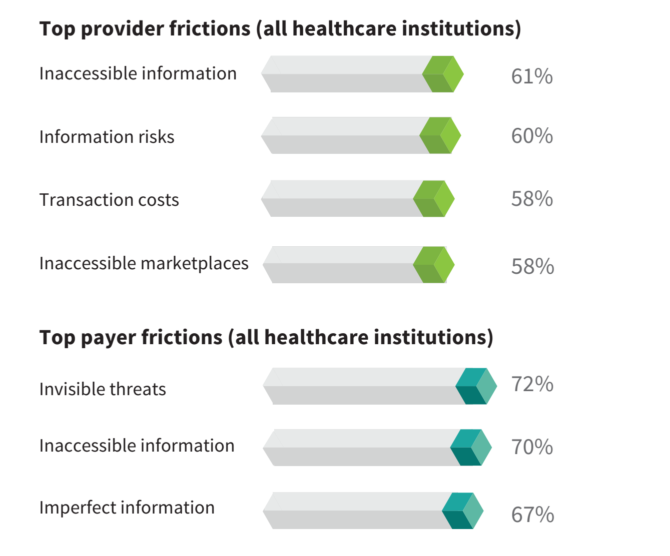
THE CURRENT SITUATION

Patient care often involves multiple clinicians who may not share information with one another. This often results in care being siloed or uncoordinated.

Duplication of services and clinical decision-making with imperfect information are all too common in the current system. Addressing the problem of fragmented care would require uninhibited sharing of all clinical records among independent providers participating in the patient's episode of care. Perhaps the most important first step in this process is the adoption of electronic health records. Although EHR adoption rates among physician practices doubled from 2008 to 2015,[2] the current system does not facilitate a seamless flow of accurate clinical information across various points in the care continuum.

Recently, the Institute for Business Value at IBM sponsored a survey of 200 health care executives of both payers and providers in 16 countries to gain insights into their thinking with regard to blockchain adoption.[3] Figure 1 illustrates some of the concerns providers and payers expressed. Both providers and payers pointed to "data and information" related risks among the top impact areas. Information risks refers to the risk of technology breaches and tampering; inaccessible information to the shortage of information arising from standards issues; shortage of scalable computing power and storage; and imperfect information to decision-making impeded by inaccurate, misleading or incomplete information. Other reports have pointed to growing expectations of blockchain adoption by the health care industry.

Figure 1
Top Provider, Payer Concerns Blockchain Might Address



Source: To what extent would each of the following challenges be reduced if blockchains were implemented in your business today? Percentage of respondents expecting a moderate or significant reduction of each friction.

Source: IBM Institute for Business Value. 2016. Healthcare Rallies for Blockchains: Keeping Patients at the Center. Executive Report: Healthcare and Blockchain. *https://www.ibm.com/downloads/cas/BBRQK3WY*. Reprinted by permission.

A 2018 Research and Markets analysis says, "The global blockchain in the health care market is estimated to amount to $5.61 billion by 2025, witnessing a double-digit growth throughout the forecast period of 2018–2025."[4]

BLOCKCHAIN TECHNOLOGY

Blockchain is a distributed ledger technology that enables digital assets to be transacted and traded in near real time. Each block represents a set of transactions that are cryptographically linked to one another, which makes them immutable.

There are two types of blockchain systems:

1. **Public blockchain.** Anyone can participate in this network. These are decentralized because no single entity has control over the network. This is also called a permissionless blockchain because the user's anonymity is protected. Anyone can read or write data to the blockchain. An example is the bitcoin network, where users can send and receive bitcoins.

2. **Private blockchain.** Entities come together to form permissioned networks. These networks are not open to all, and they operate in a similar fashion to a centralized database. One or more entities within the network may have control over it. Since these are permissioned, the identities and roles of users are well known. An example is the collaborative initiative among Aetna, Anthem, Health Care Service Corp., PNC Bank and IBM to establish a blockchain-based ecosystem.

UNDERSTANDING THE APPLICATION WITH A HYPOTHETICAL EXAMPLE

Patient care often involves multiple clinicians who may not share information with one another. This often results in care being isolated or uncoordinated. As a result, the patient suffers because the quality and efficiency of care are compromised. The provider is potentially exposed to costly medical errors that could have been easily prevented. The payer is negatively impacted because of exposure to unnecessary utilization from duplication of some services.

Blockchain technology has the potential to solve the problem of fragmented care by enabling the sharing of all health information across independent providers involved in the patient's continuum of care. We will use a hypothetical situation to see how the technology may be applied to improve patient and provider experiences.

Mr. Smith is examined by his primary care physician, Dr. Summer. The electronic health record (EHR) related to this service is stored in a centralized database at Dr. Summer's facility. A week later, Mr. Smith visits Dr. Winter, a specialist. Dr. Winter's facility requests a copy of the EHR.

Under the current system, when Mr. Smith sends his EHR to Dr. Winter using encryption technology, they both want to be certain of two things:

- The EHR is indeed that of Mr. Smith
- The EHR has not been changed either intentionally or unintentionally while in transit

Figure 2 depicts the transactions that will need to occur in order for a permissioned, secure transfer of the EHR from Mr. Smith to Dr. Winter.

Many of the challenges faced by patients, payers and providers commonly point to the need for a patient-centric model.

The blockchain system being discussed for purposes of this example is a private, permissioned and closed blockchain. It is "closed" because permission to read data has to be granted by the owner to specific participants in the private network based on need. In this system, stewardship of health data resides with the patient, not with the health care provider. Systems like these can be built on the Hyperledger[6] platform because it offers the flexibility to manage multiple permissions while addressing privacy concerns. The patient has the ability to grant (or deny) access to the EHR to any provider or other entity. As noted in Figure 2, data resides on the blockchain in an encrypted format.

POTENTIAL BLOCKCHAIN USES FOR HEALTH CARE

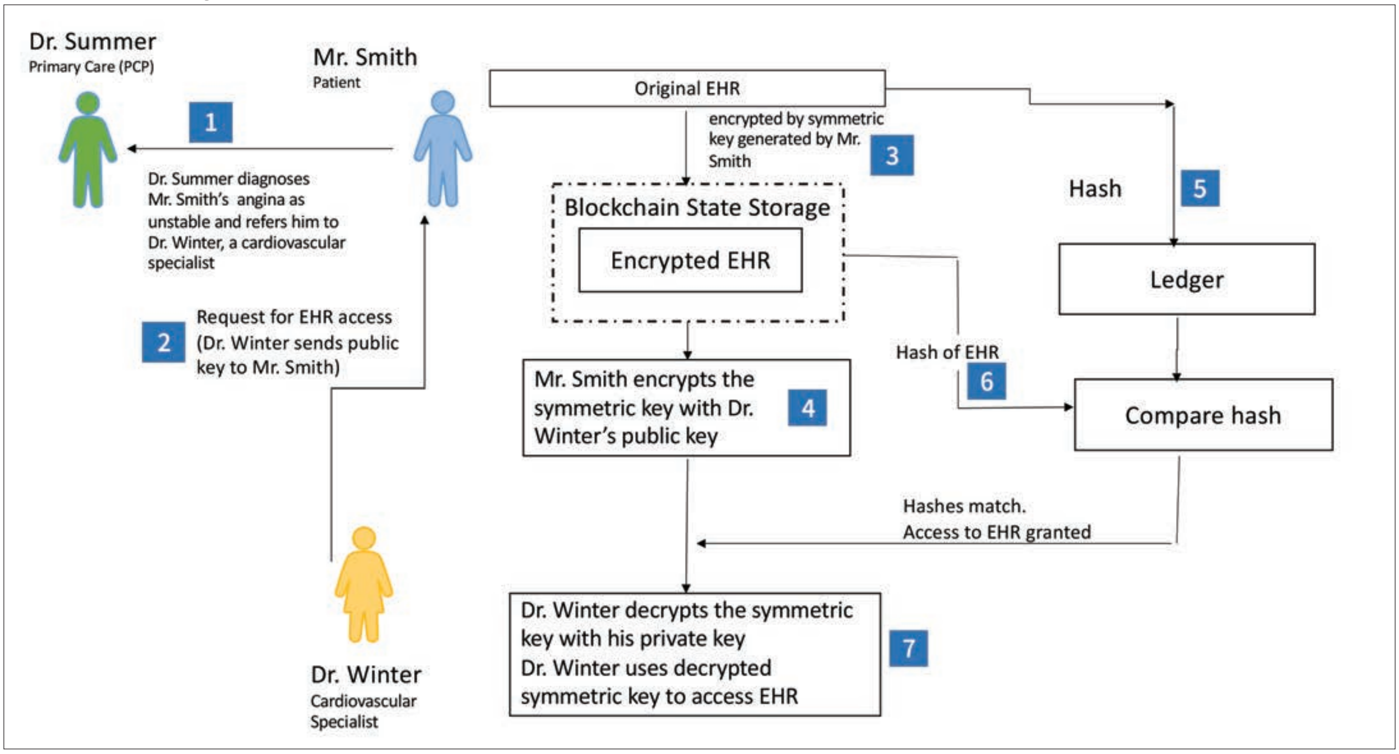
Blockchain could solve many issues, such as fragmentation of care, administration problems and data privacy. With the patient as the owner of the data instead of providers in different networks or in different specialties, the information follows the patient. Table 1 lists some of the potential uses for health care.

IMPLICATIONS FOR HEALTH ACTUARIES

Widespread adoption of blockchain technology could change the way health actuaries approach actuarial work. We could see changes in the following areas:

- **Incurred but not reported (IBNR) estimation.** Existing provider contracts could potentially be replaced by smart contracts executed on the blockchain. Such a system could significantly shorten claims processing times and could necessitate sweeping changes to traditional claim lag estimation methods.

Figure 2
Data Flow Through the Blockchain



Notes:
Hashing. The process of taking an input (data in text or any form) and running it through a mathematical function called a hashing algorithm such as SHA256 (secure hash algorithm)[5] to produce an irreversible output of fixed length called the hash value. The hash value is typically a string of alphanumeric characters and is unique to every input.
Cryptography. Ensures data integrity is not compromised. There are two types of keys used for decryption and encryption:

1. **Symmetric key.** Where the same key is used to encrypt and decrypt
2. **Asymmetric key.** Where separate keys (public and private) are used to encrypt and decrypt

Table 1
Current Problems and Blockchain Solutions

Problem	Current Practices	Blockchain Solution
Fragmented care	Rendering provider is owner of data, located in centralized server	Patient is owner of data and retains the ability to grant access to others as needed
	Longitudinal patient data is hard to obtain	Entire treatment history resides on the blockchain, which can be queried
	Treatment decisions based on incomplete clinical information	Clinicians can make well-informed decisions
	Some services/tests are duplicative	Can avoid duplicative tests/services
	Some referrals may be inappropriate because of lack of complete information	Leads to better referrals
Access to care	Physician pool often restricted to carrier network and limited by geography	Vastly extends available physician pool to global markets
	Wait times for specialists (for example, dermatologists) average about a month	Significantly cuts down wait times by engaging any available physician in the global network
	Emergency-room-only option for patient during after hours	Physicians and specialists available around the clock as physicians around the globe are engaged
	Second opinions are harder to come by	Second opinions are easy to obtain, as the same process used for first opinions can be utilized
Administration	Preauthorization process is intensive for both payers and providers	Smart contracts on the blockchain make preauthorization processes quick and accurate
	Providers' network information not readily available to patient or is outdated	Provider directories maintained on the blockchain are in sync across all stakeholders at all times
	Health care fraud from providers and/or consumers is widespread	Blockchain-enabled verifications and immutability factors allow for prevention/immediate remedies
Data privacy	Providers control patient data and decide what elements to share with stakeholders	Patient controls data and can specify elements to share with other stakeholders
Data analytics	Limited in scope because of the lack of availability of longitudinal data	More power to stakeholders, as widespread availability of longitudinal data can generate valuable insights
Internet of things (IOT)	Data from IoT wearables are not connected to health records and claims data	Data from IoT wearables can be connected to health records and claims data for better analytics
Counterfeit drugs	Difficult to track or identify counterfeit drugs	Blockchain can build anti-tampering capabilities into the system

- **Trend forecasting.** Armed with longitudinal health data that is not restricted to administrative claims or EHRs, actuaries may be able to estimate claim trends much more precisely. Traditional pricing methodologies may be replaced by sophisticated data-driven processes with increased accuracy levels.

- **Value-based contracting.** The creative side of actuaries may come to the fore with the level of information that is likely to be available in real time. This could spur the design of innovative, smart value-based contracting arrangements with providers.

- **Administrative expenses.** Blockchain technology has the potential to greatly reduce administrative cost, particularly loss-adjustment expenses when adjudication is executed through built-in smart contracts.

- **Revenue analytics.** With real-time data availability, actuaries may be able to better identify opportunities in hierarchical condition category coding as well as develop targeted Medicare stars improvement efforts.

- **Manual rating.** Rating approaches for new plans where historical claim data is not available may become more sophisticated, as health plan actuaries will be able to query the blockchain to retrieve new members' diagnoses from other data sources.

- **Value-based insurance design.** Actuaries may be able to utilize longitudinal administrative claims data and social determinants of health data to customize benefit designs to targeted subpopulations.

CONCLUSION

Blockchain technology has the potential to significantly improve the quality of life and overall health of the members of a health system, while also adding to administrative efficiencies. For the first time, we will have access to members' entire diagnoses and prescription histories, consumer behavioral attributes and other socioeconomic determinants that are valuable inputs to designing appropriate benefits and proper care management plans. Through the blockchain, we will be able to access data not just of the existing members of the health system but also of potential enrollees and new entrants. The data can be accessed by querying the blockchain through permission granted by the member. This information can be very useful in performing feasibility studies for evaluating entry into newer markets and/or newer products, developing customized care plans and designing efficient value-based contracts. By executing smart contracts on the blockchain, we will be able to achieve administrative efficiencies like never before.

The applications of blockchain technology are numerous and groundbreaking. Organizations that do not pay heed to the benefits that blockchain can bring may find themselves left behind as the rest of the industry marches forward in its quest for efficiency and member satisfaction. ■

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ENDNOTES

1 The Office of the National Coordinator for Health Information Technology. 2018. Health IT Dashboard. *https://dashboard.healthit.gov/index.php*. (Accessed Aug. 9, 2018.)

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3 IBM Institute for Business Value. 2016. Healthcare Rallies for Blockchains: Keeping Patients at the Center. Executive Report: Healthcare and Blockchain. *https://www.ibm.com/downloads/cas/BBRQK3WY*.

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