

# BLOCKCHAIN™ IN HEALTHCARE — T O D A Y —

## Creating a Patient-Centered, Global, Decentralized Health System: Combining New Payment and Care Delivery Models with Telemedicine, AI, and Blockchain Technology

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*Over the past decade, there have been many innovations in new payment and care delivery models and technology, from telemedicine to artificial intelligence (AI) to blockchain. These innovations, however, must be used in tandem to drive real change. We review each of these innovations and propose a model for how they can be combined to be greater than the sum of their parts. In doing so, we can create a global, decentralized health system that truly puts patient care at the center, while supporting and further enabling the clinicians who make this care possible, to deliver higher quality care at a fraction of the cost.*

**I**t is no secret that our healthcare system, in its current form in the United States, is beset by large and fundamental challenges. First and foremost is the rising cost of care. The

average healthcare cost per person in Organization for Economic Co-operation and Development (OECD) countries exceeds \$5,000 per year.<sup>1</sup> In the United States, this number exceeded \$10,000 per year in 2016 and is expected to hit nearly \$15,000 per year by 2023.<sup>2</sup>

Second, there is considerable disparity in access to care. Rural and sparsely populated areas in the United States (and across the world) experience a disparity in access to care. As a result, populations suffer more often from chronic conditions<sup>3</sup> than their urban counterparts.

Collaborative care, or the integration of general and behavioral healthcare, has been shown often in studies to be more effective than traditional primary care alone<sup>4</sup> in treating these chronic conditions. Unfortunately, it is not very common

in today's health ecosystem, where physical health and behavioral health are treated as separate entities.

Furthermore, the current “cookie cutter” or “one-size-fits-all” approach is pervasive in health care, leaving treatment that is tailored to the individual to be rare, even when it is shown to drastically increase positive outcomes for many patients—perhaps most notably for cancer patients.<sup>5</sup>

Finally, physician burnout remains widespread, with 42% of physicians reporting burnout<sup>6</sup> according to Medscape's latest report among US physicians. This high rate of burnout is thought to be due to factors outside direct patient care, such as bureaucratic tasks and dealing with difficult-to-use technology.<sup>7</sup>

Many attempts have been made to introduce incremental improvements to the current system. However, these attempts have proved to be the equivalent of working on an old, rusted, broken-down car with a faulty transmission—eventually, we must face the fact that we would be better off replacing the car.

What is needed is a fundamentally different health system. We need a health system that leverages new payment and care delivery models, coupled with innovative technologies, to truly put patients at the center of their care, thus creating an improved healthcare experience and better outcomes for patients at radically lower costs.

In the following sections, first, I will outline what I believe are the key solutions needed to effectively reshape health care into a more cost-effective and more patient-centric model. We will begin by exploring two care paradigms, “Direct” Care (as in Direct Primary Care [DPC])

and Collaborative Care, their advantages over other models of care delivery, and how they can be effectively linked together. Second, we will discuss the key benefits of both telemedicine and artificial intelligence (AI) (in particular, intelligent virtual assistants), and how together they can enhance Direct and Collaborative Care models. Third, we will quickly recap the topics we have discussed thus far (Direct Care, Collaborative Care, telemedicine, and AI), how they come together, and what their limitations are. Following this recap, we will examine how blockchain, or distributed ledger technology, can help us overcome some of the limitations of the models and paradigms discussed, as well as some of the challenges that are associated with blockchain solutions (particularly those involving tokenization). Finally, we will combine them all together—Direct Care, Collaborative Care, telemedicine, AI, and blockchain—into a cohesive model that can be implemented in today's healthcare ecosystem.

## **VIRTUAL, DIRECT COLLABORATIVE CARE AS FIRST LINE OF DEFENSE**

Before delving into the more technological innovations that can help reshape healthcare, it is important that we examine two key care delivery models: Direct Care and Collaborative Care.

### **Direct Care Model**

A Direct Care model forgoes third-party insurance by establishing an unimpeded financial relationship between the physician and the patient.

One increasingly common implementation of this model is DPC, in which a clinic charges a patient a low cost monthly (e.g., \$50–\$75) or an annual membership fee for unlimited access to its primary care physicians.<sup>8</sup> Using this structure, patients can connect with their doctor anytime via text, video, phone, or a same-day

clinic appointment. Many DPC clinics give their patients, or “members,” access to additional benefits, including discounts on generic medications and laboratory testing, house calls, and even certain procedures at no additional cost.

These benefits allow DPC members to rely less on their insurance plan for the majority of their healthcare needs, reserving its use for coverage of large medical expenses, which enable them to save considerably on the cost of their care.<sup>8</sup>

Direct care model also allows patients to spend more time with their doctors. Direct Primary Care physicians typically have a caseload of 500–600 patients, while physicians at insurance-based clinics might see two to three times as many patients.<sup>9</sup> Because of this higher physician-to-patient ratio, and because physicians save time by not having to request and receive prior treatment authorization for insurance reimbursement, DPC appointments can last for 30–60 minutes, compared to 13–16 minutes per appointment in the average insurance-based setting.<sup>10</sup>

The benefits of DPC are also significant for physicians. Health systems are exploring direct models as a way to combat physician burnout, as these models enable a focus on patient care rather than dealing with third-party insurers and complicated electronic health record (EHR) workflows. In fact, EHRs are cited as occupying over 50% of a physician’s work hours.<sup>11</sup>

Direct models position the physician–patient relationship at the center of the healthcare model and have enabled primary care physicians to earn more than their counterparts in insurance-based clinics (up to 1.5 times as much in annual salary),<sup>12</sup> while seeing one-half to one-third the number of patients.

Direct Primary Care also represents a path forward for eliminating fee-for-service models and moving to truly value-based care. In order for value-based care to work, however, we must reshape our definition of “primary care.” We must look for ways to treat patients holistically, with the goal of personalization and prevention. One of the most promising approaches for doing just this is known as Collaborative Care.

### **Collaborative Care**

Collaborative Care, as defined here, refers to a model consisting of equal parts of primary care, mental/behavioral health, and personalized guidance in nutrition and fitness. Research reveals that improved positive outcomes can be achieved through this integration.<sup>4</sup>

Despite their importance to overall health, diet and exercise coaching are, in some conceptions of Collaborative Care, touched on only briefly or merely included under the scope of either primary care or mental/behavioral health. However, the effects of diet and exercise on other aspects of physical and mental health are documented,<sup>13,14</sup> and addressing these areas must be integrated into a patient’s overall treatment plan in order for him or her to thrive physically and emotionally in the long term.

In this conception of Collaborative Care, a patient’s care team consists of his or her family medicine physician or internist, plus a mental/behavioral health specialist (i.e., a licensed psychotherapist or psychologist), and a nutrition and wellness coach (i.e., a registered dietitian or certified nutrition specialist). The nutrition and wellness coach possesses a working knowledge of basic exercise programming, which is applied to improve patient health by, for example, prescribing daily walks of increasing duration or basic strength training using bodyweight or resistance bands.

A large body of research would suggest that by breaking down walls between general medical needs, mental health needs, and nutrition, we can effectively reduce untreated mental illnesses, curb the worsening of chronic conditions, identify issues in food security and help patients identify healthy and cost-effective alternatives, help patients meet their personal health and wellness goals, and perhaps even prevent unnecessary procedures and hospitalizations<sup>15–23</sup>.

Clearly, Collaborative Care, especially when combined with elements of direct care models, establishes an ideal system for delivering highly personalized and prevention-focused medicine. Direct models nurture the development of long-term relationships between the patient and the doctor, allowing for a personalized approach to care delivery, while Collaborative Care enables the treatment of the whole patient, with the promise of more effective management and prevention of chronic diseases.

This notion of preventive and personalized medicine can be taken one step further with the utilization of full genomic sequencing for patients, included in the cost of their care. The insights gleaned from this testing can then be integrated into the patient's treatment plan. For example, for patients identified at highly increased risk for a certain heart condition, steps can be taken by the care team to encourage lifestyle modifications to prevent development of the condition before any signs or symptoms appear.

#### **VIRTUAL CARE TELEMEDICINE AND ARTIFICIAL INTELLIGENCE**

With that foundation, it is possible to integrate telemedicine and AI into the healthcare model.

##### **Telemedicine**

The benefits of telemedicine (using secure live video or messaging) are well documented<sup>24–26</sup>.

These benefits include enabling patient access in areas of low clinician density, connecting patients to clinicians who speak their native language, and reducing missed appointments by meeting the patients where they are—on their devices. This is especially beneficial for the most vulnerable populations, including seniors and those with disabilities and extensive comorbidities.

Furthermore, by using telemedicine as the first line of defense, significant reductions in overhead costs can be achieved by eliminating the need for a physical office location and expensive hardware/machinery<sup>25,26</sup>. Through a direct Collaborative Care model, these savings can be passed directly to patients and thus can foster the development of a long-term relationship between physician and patient.

This model stands in stark contrast to many of the larger telemedicine platforms on the market today, platforms in which appointments are one-off and transactional in nature. This transient nature of care hinders the formation of long-term relationships between a patient and a particular doctor. Experts posit that this lack of a substantial physician–patient relationship in turn results in low rates of telemedicine utilization.<sup>27</sup> Under the proposed system, patients interact with the same core care team every time, which, in addition to enabling long-term relationships, allows for personalized treatment and improved outcomes through precision medicine.

##### **Artificial Intelligence: Chatbots Using Natural Language Processing**

Virtual care can be further enhanced by the introduction of automation via digital assistants (or chatbots) using natural language processing (NLP). Digital assistants can automate clinician workflows, enabling clinicians to focus their time on patient care, not repetitive tasks, as well as

enabling a deeper level of personalization in treatment. A few key uses for digital assistants are presented in Table 1.

### Application to Practice

Patients, or “members,” would be charged a recurring monthly or annual subscription fee for unlimited access to their personal care teams. As stated earlier, core care teams would consist of a primary care physician, a mental/behavioral health specialist, and a nutrition and wellness coach; and a digital assistant would be integrated to support patients and clinicians.

From a single mobile application, members could connect to their care teams via encrypted

messaging and live video to interact with the digital assistant for symptom triage, follow-ups, assessments, for 24/7 response and connection to appropriate parties, etc., and view or manage permissions to their records.

The clinician version of this application would allow members of the care team to coordinate care, connect with their patients, review and add to records, and assign tasks to the digital assistant. Care teams could refer patients for necessary in-person care at an urgent care clinic, specialist visits, or laboratory testing, allowing members to save on their healthcare costs by reserving the use of their insurance plans for these instances.

Table 1. Application of digital assistants to improve patient care

Application	Action
<b>Symptom triaging</b>	<ul style="list-style-type: none"> <li>• Connect with patients and guide them through a series of questions regarding their histories and current symptoms</li> <li>• Deliver a report of presented symptoms and possible conditions to the patient’s physician, which the physician can consult during a follow-up appointment with the patient</li> </ul>
<b>Reminders</b>	<ul style="list-style-type: none"> <li>• Specific use cases, including to take their prescribed medications, reminders about upcoming appointments, etc.</li> </ul>
<b>Automated follow-up</b>	<ul style="list-style-type: none"> <li>• Review status of symptoms presented during a previous consultation with the physician (e.g., if a physician marks that a patient presented symptoms of cough or sore throat and was prescribed an appropriate treatment regimen, a digital assistant automatically follows up to inquire about the success of the regimen [e.g., “how has your cough been since beginning your medication?”])</li> </ul>
<b>Assessments and questionnaires</b>	<ul style="list-style-type: none"> <li>• Automate common assessments, for example, a PHQ-9 for depression to gain information for intake forms and other documents in a more user-friendly manner</li> </ul>
<b>24-hour hotlines or emergency services</b>	<ul style="list-style-type: none"> <li>• Direct patients during crises or times when care teams are unavailable</li> <li>• Instantly notify care teams and/or a patient’s dedicated emergency contact as needed</li> </ul>
<b>Automate preventive health measures</b>	<ul style="list-style-type: none"> <li>• If data points deviate significantly from the patient’s average (e.g., a decrease in step count, limited movement, and reported symptoms of sluggishness), message the patient in real time, suggesting consultation with his/her care team.</li> </ul>

Source:

PHQ: Patient Health Questionnaire.

## WHAT IS MISSING?

The system described thus far does not actively incentivize patients to engage in their care. It neither rewards patients nor gives them an opportunity to save on the cost of their care as an incentive for taking an active role in the management of their health. Neither does it enable true patient ownership of data, nor provides the opportunity for patients to safely and securely monetize their data.

If patients do not own their data or do not have sole discretion over how their data are used, the health system could theoretically sell access to patient data without restriction or use the said data for personal gain. Patients must be the sole proprietors of their data, with full discretion over how that data are used; and they should stand to benefit financially should they choose to share that data with medical researchers (e.g., payors, pharmacies, and government).

Moreover, the system should be open-source, allowing for third-party auditors to investigate the security of the platform, developers to contribute to the technology stack, and entrepreneurs to launch their own services and applications to further serve members of the community.

What about members of the community who might be unable to afford the full cost of care? Aside from the obvious social good of better serving these patients, there are also cost savings to be had by redirecting healthcare spending from reactive care (which includes immensely costly hospitalizations and procedures) to proactive or preventive care.

Furthermore, the system described relies on a centralized authority for administration of care. At any time, the centralized authority could, in theory (and oftentimes in practice), raise the prices of basic care needs, cut back on the needs/services

covered/provided, or stop honoring the rewards or discounts they might promise consumers. All parties involved in the ecosystem, including patients and clinicians, should have the right to guide how the system evolves and ensure that their best interests are preserved.

## BLOCKCHAIN FOR TOKENIZATION, PATIENT DATA OWNERSHIP, AND DECENTRALIZATION

By implementing blockchain technology in the described system, we can enable patients to benefit financially from investing in their personal health and wellness and save on the cost of their care, enable innovators from across the globe to contribute to the growth and improvement of the platform, enable patients to own and even monetize their personal health data (including medical record and genomic data), and enable patients and clinicians to guide decision-making in healthcare administration.

### Tokenizing Wellness with Smart Contracts

Healthy, engaged patients create immense cost savings for private insurers and governments. But should patients not also benefit financially from investing in their own health and wellness?

This is done already, to a certain degree, with the rewards programs used by many large private insurers. This model, however, requires the patient to trust that the insurer will (1) properly track the patient's progress, (2) issue appropriate awards that are truly indicative of the value created for the insurer, and (3) honor those rewards. Furthermore, these programs often match patients with goals predetermined by the insurer, such as weight loss or hitting a certain step count, rather than with the patient's own goals.

If patients' personal health goal is to maintain weight (for patients already at their ideal body



mass index [BMI]), or perhaps even gain weight (for underweight patients), should they not also be entitled to the same rewards? Likewise, one's insurer may offer a program for hitting 10,000 steps daily, but what if one's mobility is limited due to age, injury, or disability? Should the person not be able to still participate with a set of goals tailored to you?

What if your personal goals are entirely unrelated to the programs offered by your insurer—such as spending less time browsing on the web or using apps that might have a negative impact on those in vulnerable emotional states (e.g., Facebook or Instagram)? Should you not be rewarded for your progress in these areas as well?

Finally, patients enrolled in these programs can only use these rewards towards the cost of their care. On the contrary, these rewards can and should be an asset that patients earned and are therefore free to utilize as they see fit. You should be able to exchange these rewards for other assets or currencies, which can be spent as patients please or put toward other expenses (e.g., housing or education).

One solution is the creation of a tokenized patient incentive program that leverages Internet-of-Things (IoT) data and blockchain technology and is designed to increase patient engagement and positive outcomes. This program would allow patients to opt in to share data from the mobile applications and wearable devices they select to track and measure progress toward their personal health and wellness goals. Using these data in conjunction with smart contracts would allow for tokenized rewards issued to patients in an automated, trustless manner.

Tokens could then be redeemed by patients toward the cost of their care or be exchanged for other assets or currencies at each patient's

discretion. In this way, patients would have true, full ownership of the tokens they earn. Discounts on the cost of care might be offered for payment using tokens to provide yet another incentive for achieving wellness goals and encourage liquidity of the token supply. A similar strategy is common with cryptocurrency exchanges, using their own native token for discounts and other benefits. For example, Binance (a cryptocurrency exchange) allows users to pay trading fees in Binance coins (BNB) with their ERC-20 token (designed and used solely on the Ethereum decentralized network platform) for discounts of up to 50%<sup>28</sup>. Healthy and engaged patients enable greater cost savings on the payor side. This type of incentives program combined with the model of care described thus far could assist in mitigating the cost (fiscally and physiologically) of chronic conditions by increasing patient engagement and personal progress toward their individual goals. This aspect of tokenization allows patients to share in this cost saving and truly own the rewards (or assets) they earn.

### **True Patient Data Ownership, Monetization and Precision Medicine**

One of the biggest promises of blockchain technology in the healthcare sector lies in enabling true patient ownership of data. These data include patients' lifetime medical record, genomic sequencing data, and other patient-generated health and wellness data.

Implementing blockchain technology enables patients to control access to these data and create the opportunity for patients to monetize their data at their discretion. This stands in contrast to models in which centralized parties simply collect patient data and sell it to third parties for their own financial gain. In a blockchain-based system, patients could opt in to share their data with medical researchers (e.g., government, payors, and pharmacies) in a secure, anonymous

manner. Crucial to this system would be separate permissions for each research opportunity—accompanied by an in-depth explanation of exactly how the data will be used, how long it will be kept, and whether and how it will be deleted—rather than one single agreement to grant access for every study.

Rewards can be paid in a trustless fashion through tokens on the chain, which as previously discussed can be put toward cost of care, or traded out for other currencies, allowing patients to benefit financially from the power of their data. In this way, the financial gains from patient ownership and monetization of data could decrease or even eliminate patient out-of-pocket spending.

Furthermore, patients could decide to share their data with the platform itself in the same secure, anonymous fashion in order to drive improvement of the patient experience and increased positive outcomes. This improvement would be achieved by applying advanced machine learning techniques to these data, thus gleaning population health insights that would more effectively guide precision medicine efforts.

### **Tokenization for Care Subsidies**

Many governments and payors see the bulk of their healthcare spending go toward large medical expenses from a small fraction of the total population, a fraction in which comorbidities of chronic conditions are plentiful. In many cases, this subset of the population consists mostly of those who cannot afford high-quality care and therefore avoid treatment until emergent situations occur, resulting in costly hospitalization and intensive procedures with the taxpayer ultimately footing the bill.

Take, for example, a patient on a government-sponsored plan being rushed to the emergency

department (ED) for an attempted suicide, resulting in a hospitalization costing \$20,000. This type of incident, which the author experienced, is unfortunately much more common than anyone would like to think. Aside from saving this patient (or family) and the pain and suffering of struggling with untreated mental health issues, it might ultimately be more cost-effective to direct this spending toward preventive care.

An effective preventive care program, much like the direct collaborative care model described, would cost as much as \$200 per month\*. Hypothetically, if the government (and ultimately the taxpayer) was to pay for the cost of this care, this is just 12% of the total cost of the hospitalization previously described.

By directing spending toward preventive care, avoidable ED visits, procedures, and hospitalizations can be eliminated, decreasing the funding needed (or enabling more efficient use of current funding) for government-sponsored public health programs.

Through an allotted portion of the total token supply, or as a built-in mechanism of the previously described rewards and monetization programs, tokens can be used to subsidize the cost of care for individuals and families of low income. For example, 10% of the token rewards issued *might be tokens designed and used solely on the Ethereum platform* toward subsidies, with the remaining 90% going to the patient who earned (or in a blockchain context, “mined”) those rewards.

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\* \$200/month/patient achieves significant profit margins while covering the cost of technology and care team salaries (PCP, psychotherapist, RD). Exact breakdown of unit economics, care team assignments, and patient populations is to be covered elsewhere.



Subsidies need not cover the full cost of care. For example, their use can be pegged to a percentage of annual income—for example, if membership fees exceed 10% of annual household income, fees will be subsidized via the token supply to cap costs at 10%.

In this example, a family earning \$50,000 annually will have their annual healthcare spend capped at \$5,000, with token subsidies covering the remaining expenses and no disruption to services provided.

In this subsidized system, all members contribute what they can, but no individual or family needs to pay 50% of their income toward healthcare at the expense of affordable housing, education, job training, childcare, or proper nutrition.

Granting individuals and families with low annual incomes access to the same collaborative preventive care through the model described via subsidies can create immense long-term savings for governments and payors. Through such a system, we can effectively curb untreated mental illnesses and chronic conditions, increase productivity and earning potential, and ultimately increase the quality of life.

### **AN OPEN-SOURCE PLATFORM**

The codebase for the system would be made open-source, allowing developers and technologists from across the globe to audit and contribute to the codebase in exchange for token rewards.

Furthermore, this open-sourcing would allow entrepreneurs and innovators to create and launch their own applications and services atop the same platform. This allows opportunities for an ecosystem of applications to serve the community and its members, as opposed to just a single service.

For example, a group of developers could create an application atop this platform to aid individuals in the management of a particular chronic condition (e.g., diabetes). The developers benefit from, among other areas, ease of distribution to a wide number of patients, with full integration into the patients' existing healthcare experience. Patients in turn benefit from access to specialized tools to help them manage their conditions without disrupting, and perhaps even enhancing, how they already receive their care.

### **DECENTRALIZED DECISION-MAKING AND LEADERSHIP**

There are immense challenges and problems with centralized systems, especially on the administrative side of health care. Many of us have witnessed in our own personal lives, have heard from friends and family, or have read in the news how central authorities reduce coverage, restrict networks, and exclude some patients altogether.

To combat this, all members of the ecosystem—healthcare professionals, patients, and developers—should together guide the decision-making process for the future of the system, instead of decisions leaving at the sole discretion of corporate executives and upper management.

Although a patient-centered health system as described here would likely need to begin as centralized, it should, over time, fully decentralize the decision-making process, leaving it in the hands of the healthcare professionals and patients who interact with it every day. This can be achieved through staking and voting mechanisms similar to those being explored on Ethereum and EOS,<sup>29,30</sup> with built-in safeguards to avoid loss of funds and immense confusion as experienced in the infamous DAO incident,<sup>31</sup> and to ensure that basic levels of care will always be provided.

## BRINGING IT ALL TOGETHER

Table 2 lists advantages associated with utilization of the virtual, direct collaborative model described above, with some modifications to leverage all the benefits of blockchain technology. Figure 1 illustrates the flow of data and crypto assets.

## IMPACT ON PAYORS

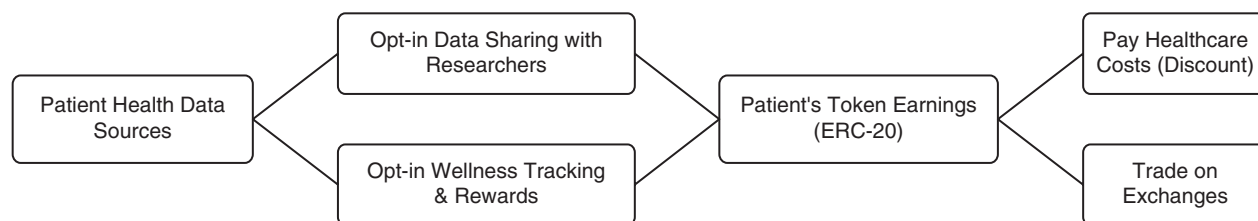
This system offers immense cost-savings for government and opportunities and challenges for private insurers.

For governments, this system could lead to huge economic benefits by mitigating untreated mental

*Table 2. Advantages associated with utilization of the virtual, direct collaborative model*

Stakeholder/device	Event
<b>Patients or members</b>	<ul style="list-style-type: none"> <li>• Charged a recurring monthly/annual subscription fee for unlimited access to a personal care team</li> <li>• Connect to care teams via encrypted messaging and live video, interact with the digital assistant (for symptom triage, follow-ups, assessments, 24/7 response and connection to appropriate parties, etc.), and view or manage permissions to their records from a single mobile application</li> <li>• View ongoing studies and research opportunities, with details describing how their data will be used and token bounties to which they are entitled for participation. Using distributed ledger technology, these data can be shared with permission of parties while preserving security and anonymity.</li> <li>• Might opt to share data with the system itself to improve the patient experience and increase positive outcomes, with the same level of detail on how data will be used.</li> </ul>
<b>Core care teams (primary care physician, mental/behavioral health specialist, and nutrition and wellness coach)</b>	<ul style="list-style-type: none"> <li>• Coordinate care, connect with patients, review and add to records, and assign tasks to the digital assistant</li> <li>• Make referrals to necessary in-person care at an urgent care clinic, specialist visits, or laboratory testing, allowing member saving on healthcare costs by reserving their insurance plans for these instances</li> <li>• Paid by default (for ease of covering personal expenses), but could be paid in tokens or a combination of their choice.</li> </ul>
<b>Digital assistant, mobile application</b>	<ul style="list-style-type: none"> <li>• Integrated to support patients and clinicians</li> <li>• Members set personal health and wellness goals and connect data from the IoT devices to track progress, with token bounties for achieving goals</li> </ul>
<b>Machine learning</b>	<ul style="list-style-type: none"> <li>• Applied to this data to glean insights for population health and precision medicine</li> </ul>
<b>Tokens and token staking and voting mechanisms</b>	<ul style="list-style-type: none"> <li>• Stored in the member's virtual wallet, where they can be put toward cost of membership or can be sent to a third-party exchange to trade for other assets or currencies</li> <li>• Allow patients, clinicians, and developers to control decision-making and advance the future of the system</li> </ul>
<b>Indigent patients</b>	<ul style="list-style-type: none"> <li>• A portion of the total token supply (or alternatively, a small percentage [<math>&lt;10\%</math>] from "mining" rewards) would contribute subsidies for those unable to afford full cost of membership.</li> </ul>

IoT: Internet-of-Things.



*Figure 1—Flow of data and crypto assets. Patients control if/how their data are shared, including medical record and patient-generated health data from wearable fitness trackers, health applications, etc. They may share their data with medical researchers and/or track progress toward individual health and wellness goals. Through both methods, patients can “mine” the ERC-20 (technical standard used for smart contracts) token of the network, which can be used to pay the cost of their health care at discounted rates or can be traded out to fiat currencies or other crypto assets on third-party exchanges.*

illnesses and chronic conditions, thus increasing productivity and earning potential, and ultimately increasing the quality of life. This enables government-sponsored/public health programs to make more efficient use of funding.

The system would also allow for private insurers to save significantly on spending by providing a redesigned first line of defense directly to consumers, specifically focusing on personalization and prevention, thereby mitigating the amount of large medical expenses that need coverage.

There is, however, a distinct possibility to disrupt existing private insurers. If enough members of the system are amassed, there becomes an option for the system itself to offer a supplemental insurance plan to fill the gaps of what is not covered by the virtual, direct collaborative model. For example, the system could give members the option to pay a small extra monthly or annual cost for full insurance coverage—no deductibles, no co-pays, just the flat fee.

When this amount is pooled across all members, it can effectively fund the full scope of care at a fraction of current individual healthcare spend, which, as mentioned previously, exceeds \$5,000

annually in OECD) countries and \$10,000 annually in the United States.

Members would still receive the majority of care through their core care team, but would now be able to rely on the supplemental plan for major medical expenses. The supplement would provide universal coverage, meaning no restriction to certain networks or hospitals, which would in turn enable more consumer choice, with care teams able to recommend best course of action. For example, let’s say this supplement for existing members is priced at just \$25/month per adult<sup>†</sup>. With 1 million adult members, this creates a monthly pool of \$25 million to cover large medical expenses (or \$300 million annually), which again in theory should be curtailed in the first place through the use of preventive care teams.

By providing this supplement, the system—thus its members, as the system is decentralized—captures the cost savings provided by focusing on personalized, preventive care. Furthermore,

<sup>†</sup> By no means is this number prescriptive. Historic healthcare spending trends would indicate that this amount need be much higher. It is merely meant to serve as an example to illustrate the power of a large and sufficiently diverse patient population.

as the decision-making process is owned by members of the system, they can ensure that the best interests of all members are preserved into the future as the system grows and develops.

## LEGAL FRAMEWORKS AND CHALLENGES

Challenges related to legal frameworks include those related to tokenized assets, the need for clarity in federal regulation, greater clarity in federal regulations, issues related to liquidity and volatility, and legislative actions by states.

### Securities versus Utility Tokens

One of the most common concerns in dealing with tokenized assets is their legal classification: will the token be considered a *security* or *utility* token? While a complete analysis of the properties and legal repercussions of securities versus utility tokens is outside the scope of this paper, it is, however, useful to introduce the basics and impacts concerning what was discussed thus far.

In US jurisdictions, whether or not an asset (or the transaction of assets) can be considered a security follows what is known as the “Howey Test”. As explained in CNBC’s interview with Securities and Exchanges Commission (SEC) Chairman Jay Clayton, “The ruling comes from a 1946 US Supreme Court case that classifies a security as an investment of money in a common enterprise, in which the investor expects profits primarily from others’ efforts.”<sup>32</sup>

Basically, if the token is purchased from a company, with the promise of financial returns from the company’s profits, the token is most likely a security<sup>‡</sup>. Think of this as purchasing

shares of a public company like Starbucks—owning said shares entitles the owner to a proportionate share of the Starbucks’ profits.

Utility tokens, on the other hand, are redeemable for products or services. As a hypothetical example, assume that Starbucks was to tokenize its rewards program. As a member of this program, people owning utility tokens could receive rewards in the form of Starbucks’ new (again, hypothetical) ERC-20 token which we will call StarbucksCoin (SBC), for regular purchases at Starbucks—in the author’s case, this would be a Vanilla Bean Frappuccino.

In this hypothetical example, it is possible to track and spend SBC from the digital wallet in the Starbucks app. As an added bonus, there is a 20% discount on all purchases made using SBC. Leftover SBC can be sent to the digital wallet of a friend or family member, or can be sold on an exchange for other digital assets like Bitcoin or Ethereum (which can then be exchanged for US dollars).

### Clarity in Federal Regulation

This type of utility token framework is ideal for building the decentralized system. Patients would be able to freely earn and spend their token rewards, and these rewards need not be restricted to “accredited investors” only—or those having a net worth of at least \$1,000,000 or an income of at least \$200,000 annually for the last two years<sup>33</sup>—less being subject to securities regulation.

At the federal level, however, the United States has yet to pass legislation or provide a legal definition of utility tokens. There is simply the existing securities legislation; if the Howey test concludes that it is a security, then it must be regulated as a security and subject to oversight by the SEC. With the Howey test at the federal

<sup>‡</sup> I am not a legal or financial expert. Nothing in this manuscript should be taken as legal counsel or financial advice.

level essentially serving as the arbiter of what is considered a security, the interpretation can be vague, as courts have used different interpretations of the *SEC vs. Howey* ruling.

Furthermore, basing decisions on a technology that arose in 2009<sup>34</sup> from a court case in the 1940s, three decades before the advent of the personal computer<sup>35</sup>, can be problematic, as new technologies have drastically transformed our landscapes and worldviews in the past few years alone. Imagine using the same regulation for horse-drawn carriages as for self-driving cars. The lack of clarity in existing legislation has resulted in the country's top legal and technical experts differing as to how to classify certain tokens or coins.

This becomes even less clear when discussing initial coin offerings (ICOs), when a coin or token is first made available to the public. To return to the previous hypothetical example, Starbucks could hold an ICO in which SBC are available for purchase. Starbucks aficionados could stock up on SBC for the discounts they afford, and Starbucks as a company can use this new wave of capital to invest in marketing, recruiting corporate talent, opening new locations, etc.

Would this hypothetical token, or its purchase, fall under federal securities regulation? With existing federal regulations, it is difficult to say. Current SEC Chairman Jay Clayton stated that all ICOs, in his eyes, are in fact securities.<sup>36</sup> Then in June, the SEC declared that Ethereum, which ran its ICO in 2015, is not in fact a security. Clayton has gone on to say that tokens “can evolve toward or away securities.”<sup>37</sup> Furthermore, according to CoinDesk,<sup>38</sup> “Clayton illustrates an example using bitcoin as one end of a spectrum, and stocks stored on a blockchain as the other: ‘The question is, where does our jurisdiction begin?’”

Admittedly, these comments sound promising, but upon reflection, they offer no concrete answers. When does a security become not a security, or vice versa? Who determines this, and what factors are these determinations based on? If the SEC says the range of tokens lie on a continuum, then how is the Howey test sufficient for determining how these tokens should be regulated?

### **Liquidity and Volatility**

How much is an individual token worth? One factor in determining the value of an individual SBC is the total supply of SBC. If the total supply of SBC is close to 100 billion units, such as in the case of Ripple (XRP)<sup>39</sup>, then the value of each individual token will be drastically different than if the total supply of SBC is closer to 21 million units, such as in the case of Bitcoin (BTC)<sup>40</sup> or ZCash (ZEC)<sup>41</sup>, due to the higher relative scarcity of tokens with a lower total supply.

Another factor is its liquidity: is there a large enough (and balanced) group of buyers and sellers active in the market? If there are only a handful of buyers and sellers of SBC, or if the sellers drastically outnumber the buyers, one would say the market for an asset is “illiquid.” Illiquidity often leads to immense volatility, where the price can change by a factor of 100 overnight. For example, 10 SBC to purchase a latte on Monday need 1,000 SBC to purchase the same latte on Wednesday.

These illiquid markets are especially vulnerable to price manipulation by “whales,” wealthy individuals or corporations owning large amounts of a certain digital asset, who may intentionally manipulate the supply (and thus price) for their own personal gain. You will notice the “top” digital assets (or largest by market cap) have a high amount of liquidity, often shown by the 24-hour trading volume.



This prevents, to a certain degree, wild fluctuations caused by imbalances of buyers and sellers that affect many smaller cap coins.

In liquid markets, the going price of an asset would naturally fluctuate with rise and fall in demand in relation to the supply. In digital asset markets especially, this demand can be heavily influenced by consumer sentiment toward news (or in some cases, just “noise”) such as corporate hirings/firings, new updates and product releases, partnership announcements, etc.

For example, if Starbucks introduces a new Frappuccino flavor (and for the sake of this discussion, let’s assume that the market for SBC is sufficiently liquid), then the demand for, and thus the price of, SBC may increase significantly for the week after the announcement. Then the price would likely regress toward average prices. By correctly timing the buying and selling of SBC, one could make a decent profit that is not linked to Starbucks’ profits or ownership of Starbucks stock. Does and should this profit potential affect the classification of SBC as a security, or not?

Some may follow this line of logic, arguing that purchasers or holders of the token are investors seeking profit from the increase in value of SBC over time, much like a venture capitalist purchasing shares in an early-stage company. Others might argue the opposite, stating that the inherent utility of the token (being redeemable for Starbucks products) and the fact that it is not at all tied to ownership, equity, or profits in or from Starbucks mean that it does *not* fall under SEC jurisdiction. Again, it is unclear. The author leans toward the latter, but regardless of what side an individual may fall in this debate, many would agree that new legislation should be brought in to support existing legislation and provide additional clarity.

### **Pioneering Legislation at the State Level**

While significant change at the federal level may take time, there have been considerable efforts at the state level to provide a clear legal framework for utility tokens, resulting in new legislation being passed in US states like Wyoming. In March 2018, Wyoming became the first to define utility tokens as a new asset class. As defined in the state of Wyoming, a token is a utility so long as the following conditions are met: (1) the token has not been marketed by the developer or seller as an investment, (2) the token is exchangeable for goods or services, and (3) the developer or seller of the token has not entered into a repurchase agreement of any kind or entered into an agreement to locate a buyer for the token.<sup>42</sup>

There are further nuances to the bill, of course, and legislation passed at the state level does not necessarily impact policy at the federal level. It does, however, show that governments can successfully pass new legislation to support existing legislations, while at the same time providing additional clarity in an ever-changing technology landscape. As evidenced by the huge wave of blockchain companies relocating to Wyoming<sup>43</sup>, these types of legislative breakthroughs can help spur immense innovation and economic growth.

### **SUMMARY AND CLOSING REMARKS**

In this article, we have explored how new payment and care delivery models can be combined with telemedicine, AI, and blockchain technology to create a truly patient-centered, global, decentralized health system.

To truly put patients at the center of care, we need to fundamentally redesign the healthcare experience and bring together the best of all the innovations we have at our fingertips.

Most importantly, we must continually redesign the experience as new technologies and new models are created.

The system must continue evolving to ensure that the highest quality care is provided. This is not only the “right” thing to do in terms of social good but also drives more positive outcomes and is more cost-effective in the long term. And isn’t just that—better outcomes at lower costs—what all of us, as citizens and as patients, want for our health care?

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