

Incentivizing change within social determinants of health using blockchain techno...

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Introduction

Social determinants of health (SDOH) have an outsized effect on individual healthcare outcomes. SDOH address the economic and social conditions that influence health status, such as physical environment, education, socioeconomic factors, social support, and access to healthcare services ([Heiman and Artiga, 2015](#)). It can be used to effectively model risk in healthcare settings (e. g., avoidable emergency department visits, admissions/readmissions, and unmanaged chronic disease conditions) using widely accessible analytical methods. The current challenge of electronic medical records (EMRs) is that they limit access and thus do not accurately represent a complete view of individual patients' health and thus inaccessible and/or unusable by those providing care. ICD-10-CM codes, which are codes that represent diagnoses and are used by physicians, payors, and epidemiologists, for example, now address SDOH and are intended to be coded by non-clinical stakeholders. However, ICD-10-CM codes do not map well to empirical social determinants, are in limited use based on economic incentive, and are inaccessible to those outside of the EMR or claims system.

A distributed ledger encompasses capabilities to keep a secure tracking of verifiable data. While the identified use cases in healthcare are numerous, one use case stands out in particular—the coordination and access to trusted data in an effort to address the SDOH. Through patient consent and partnership with key healthcare provider and payor stakeholders, a union of electronic health records and claims, and the collection of SDOH related

factors and information, it will allow for and enable in-depth scientific analysis examining patient-specific needs, intervention effectiveness, and insights into the needed evolution of healthcare to consider both clinical and social determinants to address the needs of the population.

The integration of SDOH as a clinical requirement using technology requires understanding the important role of place environment and its overall impact on health, well-being, and population-level health outcomes and the current challenges that exist today. Previous research and observations have indicated that many individuals, particularly underserved populations, often have a large distrust of provider systems, including healthcare systems ([Armstrong et al., 2006](#) ; [Armstrong et al., 2013](#) ; [Gupta et al., 2014](#)). Barriers in language and literacy among vulnerable populations present additional challenges in regard to health literacy ([Levasseur et al., 2015](#)). An individual's income level, level of education, and proximity to quality preventive services have consistently been shown to be tied to the availability of basic-level resources such as safe housing, stable food sources, physical activity levels, and overall burden of disease ([News Release, 2020](#)). Distributed ledger technology, or blockchain, presents a unique opportunity to address various socio-environmental factors and improve methods of both the delivery and management of care. In addition, implementation of strategies using distributed ledger technology provides a wide range of learning opportunities not only at the individual and population level in an effort to change behavior but also for providers, policy makers, and other key-level community stakeholders.

In an effort to address the rising cost of healthcare services, reimbursement strategies are emerging by payors and providers, including the advent of value-based reimbursement ([Gupta et al., 2014](#)). Evidence-based medical interventions and best practices, along with a renewed focus on public health and wellness, will further drive the importance of the management of SDOH as it becomes more critical for patients in the overall healthcare delivery environment. Public health has moved beyond merely understanding and preventing disease as practiced in the causes of health disparities in the 19th and 20th centuries ([Currie, 2014](#)). Now, the components of SDOH and environmental conditions are well regarded as essential to assuring overall population health coupled with any clinical intervention ([Tobin-Tyler and Ahmad, 2020](#)). Hospital and health systems need to engage and include SDOH measurement in their data analytics and population health analyses to further their care management strategies and reimbursement capabilities. Without inclusion of this input, their quality and service capability will be compromised and incomplete with implications toward reduced reimbursement, impact on reputation, and ability to retain staff and maintain clinical excellence.

Indeed, there are challenges to the inclusion of SDOH services and activities, not the least that they are often non- or under-reimbursed and are most often provided by government and/or not-for-profit social service agencies that are heavily underfunded, understaffed, or staffed by volunteers. SDOH services are now becoming recognized for the importance of their impact on population health and long-term clinical outcome. Furthermore, there remain numerous questions still to be evaluated as to the prioritization, intervention, <https://assignbuster.com/incentivizing-change-within-social-determinants-of-health-using-blockchain-technology/>

data requirements, and unintended consequences brought to bear by the inclusion and integration of SDOH. As healthcare systems have yet to fully achieve a full understanding of their capabilities, management of data, and cost equalization, this necessitates further review of how SDOH has the potential to provide a positive impact on overall health systems and their associated outcomes ([Cottrell et al., 2018](#)).

At the time this manuscript was drafted, the world was experiencing one of the deadliest pandemics in centuries, COVID-19. The skyrocketing incidence rate and virulence of the virus had caused almost every country in the world to mandate enforceable self-quarantine and stay-at-home orders to mitigate and flatten the curve of the viral spread. Within a month of the implementation of stay at home or social distancing orders, the global economy had fallen into a recession with the highest levels of unemployment recorded in recent history ([Agrawal and Shrank, 2020](#)). Within that critical period where systems were at their most vulnerable was when a blockchain solution could be most effective in supporting global needs by coordinating various response efforts, in real time, across systems in healthcare, supply chain, employee resources, nutrition and housing assistance programs, and other necessities to meet the basic needs of those experiencing sudden income loss or other key resources.

Although not a new technology, blockchain, a type of distributed ledger, has increased in popularity since 2017 as a technology that may prove to have many benefits for the healthcare industry. With secure technology and encryption mechanisms, blockchain can give rise to a new era of digital

healthcare technologies with improved access to patient data. The harmonization of this data could have large, positive benefits to supporting the SDOH.

For blockchain, 2018 was no doubt a milestone year. In 2018, over 21 billion USD ([Heiman and Artiga, 2015](#)) had been raised by over 950 initial coin offerings (ICOs). While cryptocurrency may be experiencing an adjustment, one thing is clear—blockchains' utilities across industries are poised to disrupt many of our current systems for exchanging data, information, as well as money. Within healthcare, blockchains' immutable distributed ledger offers solutions to many of the persistent pain points within our healthcare system including privacy, trusted record keeping, and data coordination/access.

Aspects of SDOH and Integration Into Existing Health Systems

A strong case can be made that social, political, cultural, and economic factors have an effect on health, upward mobility, and quality of life. SDOH in short are “ the structural determinants and conditions in which people are born, grow, live, work, and age ([Koh et al., 2011](#)).” Such determinants include, specifically, socioeconomic status, education, ethnicity, social networks, social policy, employment, and physical environment and are fundamental drivers of preventative health. Eighty percent ([Cottrell et al., 2018](#)) of total health is attributed to SDOH, and thus, identifying opportune intervention areas for prevention efforts in these areas is essential (

[HealthData.gov, 2020](#)). As more health systems move toward a value-

based care model in which payments and reimbursements are in part based
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on quality and outcome metrics, SDOH are critical to providing an encompassing understanding of an individual or group's life conditions outside of the point of care facility.

While complex, the association between economic security and health outcomes is well known ([Healthy People, 2020](#)). Lack of adequate or inconsistent income creates challenges in which regular payment is required. Social determinants most affected by financial stability include poverty, food security, healthcare, housing security, and job security. Major health systems are investing millions of funding into network community programs aimed at addressing key social determinant factors like food security and community care services ([Koh et al., 2011](#)), as well as through improved coordination of care management strategies utilizing data analytics and population-level intervention strategies. In a survey study conducted by Change Health, over 80% of respondents (largely health plans) reported building or executing initiatives in population health and value-based care medicine that address their health plan members' social needs ([Koh et al., 2011](#)). One such initiative is the Utah Alliance for the Social Determinants of Health, which aggregates community and government agency services like food security, access to housing, and transportation and helps connect them to people in need. Incentives for addressing the SDOH are rooted in optimizing value-based care payment and reimbursement models by taking into account the whole need of the patient, especially for high-cost and high-need patient groups, so that cost savings and risk sharing are maximized.

In the United States, approximately 30% of the population is either unbanked (do not have a bank account) or under-banked (have a bank account but is underutilized) ([HealthData.gov, 2020](#)). Individuals in these groups tend to be low-income, undocumented, or belong to another marginalized group where banking fees and/or fines are expensive or there exists distrust in banks and other centralized institutions. Cash and cash-based digital vehicles like gift cards become the main vehicle of transactions. It makes it hard for these groups to develop good credit history and excludes them from resources that could improve their quality of life. In this case, blockchain provides a unique opportunity to create a ledger of financial history (and therefore trustworthiness, required by lenders) while circumventing traditional third-party verifiers (e. g., banks) altogether. With a unique identifier, an immutable transactional history that is trusted and most importantly, owner mediated, is accessible to all. Qualifying for adequate housing, purchasing a car on credit, opening a mobile phone account, and other resources that require a credit check or proof of ability to pay now become much more possible for the unbanked or under-banked population.

Factors such as poverty, inadequate employment opportunities, food and housing insecurities, and education opportunity play a significant role in individuals' experiences and can drive patients to present for care, often much too late ([Krisberg, 2016](#)). In regard to the potentiality of blockchain and other distributed systems in healthcare, much of the discussion has centered solely on the technology itself. There has been very little to no discussion within various sectors of the overall social impacts, much less the behavioral impacts of blockchain utilization, specifically within healthcare. In

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further examination of how blockchain technology and other related applications may be used in a concerted effort to help improve population health, the SDOH at various levels, including factors at the individual and community level, as well as at the policy level, must be taken into consideration as they are integral to the overall discussion and pursuit of blockchain adoption and implementation within healthcare. It is important to take these factors into consideration as they currently impact the way in which individuals engage and interact with the medical and healthcare system and overall health-seeking behaviors. These same patterns may impact and heavily influence overall adoption and utilization of health-related technology. Moving forward, it will be important for healthcare systems, along with their care management modalities, to consider the best ways to initially engage individuals, especially among vulnerable populations, in an effort to improve public health and individual's health status ([Middleton et al., 2013](#)).

While blockchain offers solutions, tools, and resources to address and improve health, it is not without challenges. Utilizing blockchain technology in healthcare offers the ability to increase transparency, allow patients to have ownership over their data, and reduce fraud. However, questions remain such as how the use of blockchain technology can lead to improvements in other healthcare access-related barriers, such as patient engagement and patient- and physician-level access, as well as address other SDOH related factors.

The Blockchain Opportunity

The crux of improved patient care is dependent on our ability to link individuals to their individual-level records. For the first time in history, blockchains allow for the automation of the irrefutable trust that that linkage is true. A blockchain is defined as a distributed ledger or an unchangeable (immutable) record of transactions. As an immutable audit trail that allows for programmable contracts (aka smart contracts), blockchains are protocols that create trust ([Coinschedule, 2018](#)). This is significant, for example, when verifying patient identity, including name and birthdate, medical history, assets, and any transactions associated with that individual identity. When building a blockchain, a transaction or record is written on a “ block.” Multiple blocks can be linked together in a “ chain” based on a set of criteria to create a chain of those blocks called the “ blockchain.” That chain is then recorded on every computer that is part of that blockchain’s network, making it extremely difficult to change without the approval of every computer in that network. As an incorruptible distributed ledger, it has the potential to improve healthcare data management, enhance distribution, provide better access to data, and lower costs associated with these tasks, and linking individuals with their records becomes essential to improving care ([Pewtrusts.org, 2018](#)).

Blockchain can enable big data and advanced analytics to achieve integrated collaboration and team-based, person-centered, and health-focused care, which are key factors in improving the aforementioned factors. Healthcare, while advanced, is inconsistent in terms of cost, access, and outcomes.

Anticipated population growth, demographic change, and advances in

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medicine and healthcare technology mean that the cost of care is likely to continue to grow, unless we can innovate to deliver better healthcare and better health outcomes while using resources more efficiently. Healthcare needs to go beyond incremental change in an effort to achieve significant and sustainable improvements in the quality of care, population-level health, and affordability. In ensuring a sustainable healthcare infrastructure into the future, innovation is a necessity. A key transformation strategy is to have patients informed, engaged, and activated through evidence-based strategies, consistent with their values, goals, and preferences, and effective in their personal and social milieus ([World Health Organization, 2003](#)).

Empowering individuals, including both patients and providers, through the use of blockchain and artificial intelligence (AI) and machine learning (ML), would potentially allow for the delivery and receipt of the best evidence-based and personalized care across the continuum of care through improved data collection, management, and real-time integration and analysis ([Zanetti and Bhatt, 2014](#)). In addition, leadership roles will shift to address new values, new competencies, emerging trends, and demands for consumers as co-designers of care ([Monegain, 2018](#)). The recent increment in engagement and efforts of the healthcare community to embrace SDOH and population health analytics, combined with recent developments in blockchain technology, are creating new opportunities for AI applications. As previously mentioned, blockchain implementation is not without its challenges. AI technologies can also be incorporated and utilized to help solve many of those challenges.

Blockchain also offers solutions to some of the biggest pain points of aggregating data management such as permissions, privacy with zero proof knowledge, and efficient coordination of multiple data sets. Leveraging SDOH requires access to various types of data (e. g., clinical, demographic, geographical, educational, socioeconomic, etc.) ([Magnan, 2017](#)) in order to run predictive analytics and guide programs and policy for the most vulnerable groups. In 2017, the Centers for Disease Control and Prevention initiated a set of proof of concepts around public health surveillance using blockchain technology with the intent to build real applications in 2018. The agency cites blockchain's ease in coordinating and distributing data in a manner that is secure, compliant, and transparent as validation for its value proposition ([Orcutt, 2017](#)). Those working in public health and at the intersection of public health could benefit significantly from adoption of blockchain technology into their work.

Therefore, opportunities in leveraging blockchain for SDOH include strengthening existing Health Information Exchanges (HIEs) and the creation of new information exchange system. As part of recent legislation (the 21st Century Cures Act), the Office of the National Coordinator for Health Information Technology (ONC) was charged to develop policies to support the exchange of information on a national scale. The Trusted Exchange Framework and Common Agreement (TEFCA) as proposed by the ONC has proposed a series of health HIEs to address adequate patient matching.

This is now a national imperative in the United States. In regard to improving health information exchanges and capturing patient-level data, an

incorruptible distributed ledger (blockchain) offers solutions to many of the pain points in healthcare and public health management such as establishing a trusted network, lowering the cost per transaction, and creating a master patient index. To most effectively leverage the SDOH to improve health and reduce overall burden of costs, it will be necessary to track those determinants at the individual level and to be able to connect, or match, them to other groups to which they might belong. Being able to do so helps to create a clearer and more consistent picture of that individual's social, cultural, political, economic, and environmental needs, and challenges in relation to maintaining their health, effectively allowing for better individual-level and population-level interventions.

In a 2017 report, Deloitte describes the need for an ecosystem approach (www2.deloitte.com, 2017). This approach requires coordination between “ hospitals and health systems working with health plans, federal, state, and local governments, community organizations and local businesses, employers, and families, to implement initiatives that impact health and quality of life.” Blockchain technology can provide a method to link these data in a way that is trusted, safe, private, and shareable. In the healthcare setting, high costs associated with hospital readmissions and ER visits for conditions that are preventable are a universal concern. Programs addressing SDOH, especially for the most vulnerable populations, allow for more effective care coordination around issues like inadequate housing, poor financial stability, little access to good nutrition, and poor social support—all which have been shown to improve total health.

Connecting the pockets of data among the numerous institutions and services that an individual may frequent for care has been a significant pain point and barrier to developing effective SDOH programs.

Social determinants of health play a large role in preventative health by identifying the social conditions that tend to aggravate or accelerate disease, and provide guidance on interventions that can slow or prevent the onset of disease. Much of this network of factors are poorly tracked and live in siloed pockets of data distributed among a variety of organizations (or departments) involved in the delivery or management of services. Building a behavioral and environmental profile on an individual or group of people is conditional on the ability to link a string of distributed data points in order to start to see the larger story behind an individual's health needs. Whether in terms of early detection or tracking disease outbreak/progression, vaccination availability and activity, clinical trials, and pharmaceutical tracking and recall, these ongoing public health challenges could all benefit from an immutable ledger of data that cannot be corrupted or altered. The ability it provides in aiding public health officials to be able to move quickly and precisely through the ease of access and secure data is essential in their success in protecting population health overall.

An example of how this can be applied to current workflow systems can be applied to Meals on Wheels. Meals on Wheels, a non-profit delivering meals to America's seniors also doubles as the only "eyes and ears" for some of the most vulnerable citizens in the United States. Aside from providing meals, they are able to assess seniors' housing conditions and mental state

and offer a bit of companionship at each visit, providing a type of surveillance that is difficult to do at scale. That surveillance, however, has little benefit unless a coordinated safety net system exists when risk indicators present. With this use case, a blockchain solution using hash identifiers for each senior could coordinate siloed data sources to identify those indicators in real time for each person, while utilizing zero knowledge proof to maintain privacy. Furthermore, an AI/ML layer could guide this system to automate the distribution of resources via smart contract programming when those high-risk indicators arise in surveillance. This type of coordinated and automated system currently does not exist and could be streamlined using blockchain or distributed ledger technologies.

Reference Architecture

In an environment where no single central authority exists and information must be distributed with access to all stakeholders, a blockchain solution can help solve critical problems of trust, consensus, and privacy. However, blockchain alone is insufficient to meet the complex needs of patients, providers, insurers, governments, and the broader network of critical social and community healthcare services. The proposed reference architecture establishes a set of key capabilities and high-level detail of the system components.

Actors:

- i. Patient (caregivers).
- ii. Healthcare organizations (healthcare providers).

iii. Social service organization (social service providers).

iv. Trusted Analytics Organization (TAO).

Capabilities

Identity and attribute management

- Patient and provider identities

- Duplicate entity management

- Lost credentials

- Linking accounts

- Delegation

Consent and associate agreement management

- Permission granted by patient

- Agreement between wellness and healthcare

provider organizations

Encounter tracking

- Historical tracking of: participants,
- Measurements
- Services rendered
- Assessments of need
- Updates and record correction
- Annotation (patient or provider)

Privacy protection

- Encryption
- Secure messaging
- Provide patient with access to all of their data

- Retention and data privacy policy
- Right to be forgotten
- Right to change data

Analytics

- Registries
- Utilization
- Trends
- Outlier detection and alerts
- Impact assessment

Blockchain technology allows for the decentralized tracking of patient data and provider encounters. The reference architecture is based on a private

Ethereum-based network. The blockchain network provides secure transactional capabilities.

1. Data can be recorded from any organization without need for central administration.
2. Distribute data (transaction) across multiple locations—there is no dependence on a single hosting organization.
3. Once entered, data cannot be changed. Corrections can be appended to the chain and new information can be added while maintaining complete historical integrity.
4. Users can trust transactions without needing to trust the participants or holders of the data.
5. Shared ownership and validation ensure that a network can persist even if the initial hosting organization disengages.

Consensus

In the reference architecture, a private Ethereum network is deployed to allow for decentralization and distributed without the transaction cost of a public blockchain. Using a proof of authority (PoA) algorithm provides a more secure, less computationally intensive, and more performant solution than proof of work (PoW) and does not require management of cryptocurrency tokens as would a proof of stake (PoS) approach. Any number of read-only nodes could join the network; however, only authorized ones are explicitly allowed to create new blocks and secure the blockchain. Once a block is signed off by the majority of authorities, it becomes a part of the permanent <https://assignbuster.com/incentivizing-change-within-social-determinants-of-health-using-blockchain-technology/>

record. While anyone with access to the network could establish a node, only nodes corresponding to account addresses are stored in a validator contract. While the PoA architecture provides higher transaction volumes and does not require cryptocurrency management, it does forgo some degree of decentralization, but in small regional settings, this may be inevitable if other parties are not capable of hosting their own nodes. In larger communities or regions, the number of participants will provide a significant degree of decentralization.

It should be noted that decentralization is not required for the purposes of improving healthcare outcomes by leveraging the SDOH. It is an inherent aspect of healthcare that must be overcome. Blockchain accommodates a decentralized organizational model and is not being deployed in order to force a decentralized system of care.

Analytics and Modeling

The focus of using blockchain in healthcare is to collect patient, provider, and encounter data with a focus on SDOH. The blockchain enables patients, physicians, care coordinators, social services, and caregivers to track encounters, needs, and healthcare outcomes. The blockchain network provides a secure means for accomplishing this. However, in order to derive useful insights from the data collected, additional infrastructure is required. Population health, risk management, intervention and treatment efficacy, and service allocation all require substantial analytical reporting capabilities. ML models, with their ability to extract key insights from the data, are required to be able to understand the relationships between SDOH and

health outcomes. These reporting and analytical needs require a data warehouse layer in the reference architecture. Data extraction, exchange, and storage must be implemented with the same focus on security while allowing patients full control and visibility of their data.

Data Exchange, Smart Contracts, and Information Consent

A number of smart contracts are required to implement provider and patient setup, account linking, SDOH data collection, data updates to historical transactions, and consent agreement management. Granting consent results in a set of data elements being populated and encrypted in the same manner as the encounter data. A transaction is sent to the TAO account to record the updated consent information for the associated patient.

Withdrawal of consent creates a new consent transaction and updates the end date-time field for the patient's account and sends a new transaction to the TAO's account recording the new consent status.

Where patient consent exists at the time of transaction, a copy of the data is encrypted using the TAO public key. These data are now safe to send over a public network to be securely managed behind a firewall in a HIPAA-compliant manner. If a patient record does not exist at the time of transaction, government regulations allow for de-identified, anonymized information to be exchanged for the purpose of managing population health and managing social and healthcare services.

Where a Business Associate Agreement exists between the TAO and a healthcare provider, the provider may request records of their transactions for the appropriate patients. Conversely, a healthcare provider may send <https://assignbuster.com/incentivizing-change-within-social-determinants-of-health-using-blockchain-technology/>

data to the TAO for the purpose of augmenting reporting or modeling based on the SDOH data and encounter information for the blockchain. Patients may initiate or approve a request for data that use their private key to decrypt a range of historical data from the blockchain and serialize it into an encrypted message to the requestor to be stored off-chain.

Data Warehousing

Data exported from the blockchain is managed based on consent. A full data set of de-identified data may be stored in a secure data warehousing platform to allow for population health modeling and assessment. A second data set containing Personal Identity Information (PII) is maintained separately. In accordance with HIPAA and established Business Associate Agreements, this data set may be combined with electronic health record, claims, and pharmacy information to provide a more individualized risk assessment and recommendations for services, care programs, and other forms of support. This information helps physicians, clinicians, and other healthcare and service providers to identify key patterns in health, illness, and disease. The data provide a comprehensive picture that can help determine the use of various evidence-based interventions, strategies, and recommendations and the appropriate course of treatment. It may also enable providers to be able to more clearly communicate and allow for patients to have a more involved say in their care. Through the ability to integrate individualized data within the clinical and social context, this will help enable the assessment of broader community-wide efforts to improve population health.

Conclusion

The barriers to data sharing among clinical entities are breaking down as technology solutions become evident and accepted. Blockchain technology provides the means to create a trust protocol verifying identity and transactions. The call for innovative strategies as well as growing case studies and research on feasibility and effectiveness of blockchain should ensure the integration of the five key domains of the SDOH: (1) economic stability, (2) education, (3) health and healthcare, (4) neighborhood and built environment, and (5) social and community context in an effort to target the complexities of prevention and intervention ([McGinnis et al., 2002](#) ; [Gupta et al., 2014](#)). The ability to trust the process, trust the security, trust the identity, and intersect with clinical and public health imperatives will enhance data management and care coordination and improve the process and outcome of individual and community health.

Healthcare is advanced but not reliable. Anticipated population growth, demographic change, and advances in medicine and healthcare technology mean that the cost is likely to continue to grow, unless we can innovate to deliver better healthcare and better health outcomes while using resources more efficiently. Healthcare needs to go beyond incremental change to achieve significant and sustainable improvement in quality, population health, and affordability. In ensuring that our healthcare system is sustainable into the future, innovation is a necessity not a luxury. Blockchain can enable big data and advanced analytics to achieve utmost collaboration and team-based, person-centered, and health-focused care. A key transformation is to have patients informed, engaged, and activated through

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evidence-based strategies, consistent with their values, goals, and preferences, and effective in their personal and social milieus. Empowered and technology-savvy individuals, using blockchain and AI would potentially receive the best evidence-based and personalized care across the continuum of care.

Leadership roles will shift to address new values, new competencies, emerging trends, and demands for consumers as co-designers of care. The incentivization for change lies on the premise of this emerging technology being able to reconcile elusive data for advanced preparation in determining health outcomes. The recent increment in engagement and efforts of the healthcare community combined with recent developments in blockchain technology are creating such new and much-needed opportunities. We recommend further research on the advent of data analytic platforms with blockchain technology. We believe that these data will provide researchers with direction to evaluate the impact of these technologies.

Author Contributions

All authors contributed to the overall development, writing and editing of the manuscript.

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Conflict of Interest

CM was employed by the company Patientory, Inc. and JC was employed by Moda Health. CM, MF, and JF were board members of the Patientory Association.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Agrawal, S. K., and Shrank, W. H. (2020). Clinical and social risk adjustments—reconsidering distinctions. *N. Engl. J. Med.* 382, 1581–1583. doi: 10.1056/nejmp1913993

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

Armstrong, K., Putt, M., Halbert, C. H., Grande, D., Schwartz, J. S., Liao, K., et al. (2013). Prior experiences of racial discrimination and racial differences in health care system distrust. *Med. Care* 51, 144–150. doi: 10.1097/mlr.0b013e31827310a1

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

Armstrong, K., Rose, A., Peters, N., Long, J. A., McMurphy, S., and Shea, J. A. (2006). Distrust of the health care system and self-reported health in the United States. *J. Gen. Intern. Med.* 21, 292–297. doi: 10.1111/j.1525-1497.2006.00396.x

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

<https://assignbuster.com/incentivizing-change-within-social-determinants-of-health-using-blockchain-technology/>

Coinschedule (2018). “ *Coinschedule – Cryptocurrency ICO Statistics*”, *coinschedule.com*, 2018. Available online at: <https://www.coinschedule.com/stats.html?year=2018> (accessed January 31, 2019).

[Google Scholar](#)

Cottrell, E., Gold, R., Likumahuwa, S., Angier, H., Huguet, N., Cohen, D., et al. (2018). Using health information technology to bring social determinants of health into primary care: a conceptual framework to guide research. *J. Health Care Poor Underserv.* 29, 949–963. doi: 10.1353/hpu.2018.0071

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

Currie, D. (2014). Health findings. *The Nation's Health* 44: 21.

[Google Scholar](#)

Gupta, C., Bell, S. P., Schildcrout, J. S., Fletcher, S., Goggins, K. M., Kripalani, S., et al. (2014). Predictors of health care system and physician distrust in hospitalized cardiac patients. *J. Health* 190, 44–60. doi: 10.1080/10810730.2014.934936

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

HealthData.gov (2020). *HealthyPeople.gov, Health People 2020*. Office of Disease Prevention and Health Promotion. Seattle: HealthData.gov.

[Google Scholar](#)

Healthy People (2020). *Office of Disease Prevention and Health Promotion*. Available online at: <https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources> (accessed March 21, 2019).

[Google Scholar](#)

Heiman, H. J., and Artiga, S. (2015). Beyond health care: the role of social determinants in promoting health and health equity. *Health* 20, 1-10.

[Google Scholar](#)

Koh, H. K., Piotrowski, J. J., Kumanyika, S., and Fielding, J. E. (2011). Healthy people: a 2020 vision for the social determinants approach. *Health Educ. Behav.* 38, 551-557.

[Google Scholar](#)

Krisberg, K. (2016). Shift toward social determinants transforming public health work: targeting causes of health disparities. *The Nation's Health* 46, 1-21.

[Google Scholar](#)

Levasseur, M., Généreux, M., Bruneau, J. F., Vanasse, A., Chabot, É, Beaulac, C., et al. (2015). Importance of proximity to resources, social support, transportation and neighborhood security for mobility and social participation in older adults: results from a scoping study. *BMC Public Health* 15: 503. doi: 10.1186/s12889-015-1824-0

<https://assignbuster.com/incentivizing-change-within-social-determinants-of-health-using-blockchain-technology/>

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

Magnan, S. (2017). *Social Determinants of Health 101 for Health Care: Five Plus Five. NAM Perspectives*. Washington, DC: National Academy of Medicine.

[Google Scholar](#)

McGinnis, J. M., Williams-Russo, P., and Knickman, J. R. (2002). The case for more active policy attention to health promotion. *Health Aff.* 21, 78–93. doi: 10.1377/hlthaff.21.2.78

[PubMed Abstract](#) | [CrossRef Full Text](#) | [Google Scholar](#)

Middleton, B., Bloomrosen, M., Dente, M. A., Hashmat, B., Koppel, R., Overhage, J. M., et al. (2013). Enhancing patient safety and quality of care by improving the usability of electronic health record systems: recommendations from AMIA. *J. Am. Med. Inform. Assoc.* 20, e2–e8. doi: 10.1136/amiajnl-2012-001458re

[CrossRef Full Text](#) | [Google Scholar](#)

Monegain, B. (2018). “ *Social Determinants of Health gain traction as United Healthcare and Intermountain Build New Programs.*”, *healthcareitnews.com*, 2018. Available online at: <https://www.healthcareitnews.com/directory/intermountain-healthcare> (accessed January 31, 2019).

[Google Scholar](#)

News Release (2020). Accessed at: <https://www.dol.gov/sites/dolgov/files/OPA/newsreleases/ui-claims/20200551.pdf> (accessed January 17, 2020).

[Google Scholar](#)

Orcutt, M. (2017). *Why the CDC thinks blockchain can save lives*, *technologyreview.com*. Available online at: <https://www.technologyreview.com/s/608959/why-the-cdc-wants-in-on-blockchain/> (accessed February 1, 2019).

[Google Scholar](#)

Pewtrusts.org (2018). “*Enhanced Patient Matching Is Critical to Achieving Full Promise of Digital Health Records*”, *Pewtrusts.org*, 2018. Available online at: <https://www.pewtrusts.org/en/research-and-analysis/reports/2018/10/02/enhanced-patient-matching-critical-to-achieving-full-promise-of-digital-health-records> (accessed February 1, 2019).

[Google Scholar](#)

Tobin-Tyler, E., and Ahmad, B. (2020). *Marrying Value-Based Payment and the Social Determinants of Health through Medicaid ACO's*. New York, NY: Milbank Memorial Fund.

[Google Scholar](#)

<https://assignbuster.com/incentivizing-change-within-social-determinants-of-health-using-blockchain-technology/>

World Health Organization (2003). *The Social Determinants of Health, The Solid Facts*. 2nd Edn. Geneva: World Health Organization.

[Google Scholar](#)

Www2. deloitte. com (2017). “ *Social Determinants of Health: How are Hospitals and Health Systems Investing in and Addressing Social Needs?*”, *Www2. deloitte. com, 2017*. Available online at: <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/life-sciences-health-care/us-lshc-addressing-social-determinants-of-health.pdf> (accessed February 1, 2019).

[Google Scholar](#)

Zanetti, C., and Bhatt, J. (2014). *Big Data with A Personal Touch: The Convergence of Predictive Analytics and Positive Deviance*. New York, NY: Huffington.

[Google Scholar](#)