INNOVATION

Can Decentralized Autonomous Organizations (DAOs) Revolutionize Healthcare?

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Exploring the opportunities and potential benefits of DAOs in healthcare.

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Healthcare is rapidly advancing in terms of technological uptake, representing one of the largest segments of artificial intelligence (AI) applications (Amante, 2022; Garbuio and Lin, 2019). Together with modern biotechnology for healthcare applications, 'smart' healthcare makes use of technologies such as Internet of Things (IoT), wearable devices, cloud computing, big data, 5G, microelectronics, and AI (Tian et al., 2019). These applications play important roles in monitoring and disease prevention, diagnosis and treatment, hospital management, health decision making, and medical research (Tian et al., 2019). The evolution of smart healthcare has allowed for the implementation of surgical robots, intelligent diagnostic support systems and data management systems, telemedicine, among many other tools (Garbuio and Lin, 2019).

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Despite all these advances, the processes of accessing health, paying for it, and interacting with medical professionals have largely remain unchanged. Being bounded by old access and governance rules has prompted a lack of trust, and promoted access inequalities (Blanchette, 2022). This may change in the future though, owing to increased adoption of blockchain applications. One such application is decentralized autonomous organizations (DAOs), whereby healthcare actors such as patients, health institutions and doctors, researchers and insurance companies may participate as members of the DAO (Wang et al., 2018), increasing trust between actors and promoting transparency.

What Are DAOs?

DAOs are blockchain-based organizations of decentralized and autonomous management, which do not involve central control and hierarchies. DAOs are fed by a network of contributors (investors in cryptocurrencies) and operate on automated rules encoded in computer programs, also called 'smart contracts'. As such, their governance is automated and based on a combination of on-chain (machine consensus) and off-chain (voting rights) mechanisms, which in turn support community decision-making and drive distributed trust among peers. All transaction records and administration rules are registered and maintained in the blockchain (Liu et al., 2021; Santana and Albareda, 2022; Wang et al., 2018).

The first step on creating a DAO is the publication of a proposal, which is elaborated by the founders in a seminal document, the "DAO whitepaper". This document presents the original concept of the project, along with other data such as technical, organizational, and investing information. The founders also make the code of blockchain and smart contract available to promote collaboration with other interested developers (Arruñada and Garicano, 2018; DuPont, 2017; Santana and Albareda, 2022). Then, the initial financial stage starts through initial coin offerings (ICO). Cryptocurrency holders that invest in DAOs become members and receive DAO tokens which translate into rights in the organization such as voting and discussing of proposals (Santana and Albareda, 2022). At the end of the financing stage, the DAO starts running.

Although early DAO projects failed due to hacking, this hasn't stopped new DAOs from being created. As of November 2022, over 200 DAOs, involving different fields such as finance, art, gaming and solidarity, are operating according to the DeepDAO database, and over 9000 are in pre-launching stages. Usually, each DAO has a specific goal and focuses on different challenges. Examples include Decentraland: a virtual world governed by a DAO on which members can build their own environments and communities and which is becoming popular among brands such as Coca Cola and Adidas aiming at reaching out digital-native audiences (Marr, 2022; Santana and Albareda, 2022). One case is that of Pleasr, constituted by a collective of artists and art lovers that invest in digital artwork through a DAO, in which members agree on the pieces they believe represent important

ideas and causes, and each member owns share of the growing collection (Marr, 2022). DAOs have current and future applications in different fields such as finance, data management, business, and we argue, in healthcare.

DAOs in Healthcare – A Few Examples

The Healthcare sector involves a range of actors such healthcare providers, medical device and other technologies' manufacturing companies, pharmaceutical and biotechnological research and development industries (Boss, 2022) and managing agents. The possibilities of incorporating DAOs in the field are numerous. These can especially contribute to increased access, both for patients and for smaller research and manufacturing institutions, and to increase transparency and community participation in the often monopolistic and opaque governance and management of the sector.

To the best of our knowledge, most healthcare DAOs are still in pre-launch stage and are mainly related to funding and supporting medical and biotechnological research. In this section, we summarize some of these DAOs that are emerging now in the healthcare space. **AntidoteDAO** is in the pre-launch stage and aims at directly funding cancer research, allowing to decrease the time and effort researchers spent on applying for traditionally funded grants and making the process more transparent, democratic, and collaborative. **VitaDAO** is an already operational DAO which is focused on funding longevity research and drug development projects while promoting open science principles, reducing funding decisions lifecycles, and democratizing ownership. As of 2022, VitaDAO has over 1300 token holders and has allocated over $3 million to research projects. **BioDAO** aims at supporting and funding early-stage biotechnology projects and decentralized drug development. BioDAO will initially focus on funding and developing therapeutics and applications based on AI and machine learning, while it will later expand into diagnostics and biotech applications. In table 1, you can find these and other examples of DAOs in the healthcare field.

Table 1 – Examples of DAOs in the healthcare field

DAO	The challenge	Mission[1]	Stage
AntidoteDAO www.antidotedao.org	Cancer is the second largest cause of death worldwide and both traditional grant funds and charities fall short to support the research needed to prevent and finding a cure for cancer.	"Our mission is to directly fund cancer research, making it more democratic, transparent, and collaborative in the process"	Pre-launch
BioDAO www.biodao.xyz	Traditional funding and development approaches in biotechnology leave gaps in early-stage research focusing on clinic-ready projects or projects by famous labs and founders. As such, investment constantly flows mostly to pre-selected research institutions.	"Our mission is to create a global democratic biotech ecosystem focused on identifying, funding, and supporting real-world biotech projects to accelerate biotech innovation and solve humanity's most pressing challenges"	Pre-launch
CureDAO www.curedao.org	Data health and innovation is still falling short regarding measurable gains in health costs and human lifespan. Digital apps often overlap in functionality representing duplication of effort.	"CureDAO is creating an open-source platform to discover how millions of factors like foods, drugs, and supplements affect human health. We're on a mission to democratize clinical research"	Pre-launch
GenomesDAO https://dao.genomes.io	Incumbent genomic data companies fall short on technological standards, lack of data sovereignty and privacy protection.	"In order to increase the democratization and decentralization of genomic studies, we focus on combining cutting-edge technologies such as AMD's SEV, blockchain and decentralized finance"	Active
VitaDAO www.vitadao.com	Biopharma institutes depend on intellectual property (IP) assets and patents to drive innovation and funding. In turn, business models carry severe limitations and R&D inefficiencies due to the processes involved with IP.	"VitaDAO is a DAO collective for community-governed and decentralized drug development. Our core mission is the acceleration of research and development (R&D) in the longevity space and the extension of human life and healthspan"	Active

[1] Quoted from the DAO website or whitepaper

The Future of DAOs in Healthcare

Although we have given a few examples, the use of DAOs in healthcare is still incipient and focused on funding research. As such, although these DAOs are related to healthcare field, DAOs in access and healthcare management are still to come. The potential of blockchain applications in healthcare has already been recognized. Blockchain allows for

decentralization, improved data security and privacy, health data ownership, data availability and robustness, transparency and trust, and data verifiability (Agbo et al., 2019; Goldsby and Hanisch, 2022; Schmeiss et al., 2019). The most common current application of blockchain in healthcare is the management electronic medical records. Other applications include the detection of prescription drug fraud and the facilitation of remote patient monitoring (Agbo et al., 2019).

DAOs are a logical next step in the journey of applying blockchain technology to increase efficiency and transparency of healthcare systems. DAOs could, for instance, replace traditional healthcare insurance companies. If so, claims could be settled instantly once the predefined conditions of the smart contracts are triggered (Wang et al., 2018), reducing frauds and mistakes as well as costs. DAOs can also bring healthcare into the emergent 'metaverse', i.e. a virtual environment which merges the physical and digital world, resorting to Web and extended reality technologies (Lee et al., 2021). This could contribute to reducing barriers in the traditional health systems, such as cost, inconvenience, discomfort, and lack of holistic support while also promoting healthier lifestyles through gamification (Blanchette, 2022). DAOs can also play a role on pandemic management and prevention (Amante, 2022). Moreover, DAOs may play an important role on democratizing health records, providing simple methods for patients to allow or restrain external access to their data. This could contribute to ameliorating data-based research which can in turn accelerate the discovery of new diagnosis and treatments. The current healthcare industry in most countries, is of a monopolistic nature, and therefore DAOs could contribute to increased accessibility to resources. In another perspective, the healthcare sector profits remaining high, and management decisions such as executives' bonuses are often non-transparent (Boss, 2022). With DAOs, the agency costs would decrease due to the absence of a managerial board and the community-based decisions would allow for increased transparency and trust (Boss, 2022). In figure 1, we provide a summary of opportunities for DAOs in healthcare, based on two pillars – (1) accessible and transparent governance, (2) funding and investment. Being healthcare is a highly regulated field aligned with the still embryonic state of DAOs, we guess there is still a long way to go before we have healthcare institutions governed by DAOs. Nevertheless, the potential is real, and we believe we will continue to hear about these progresses.
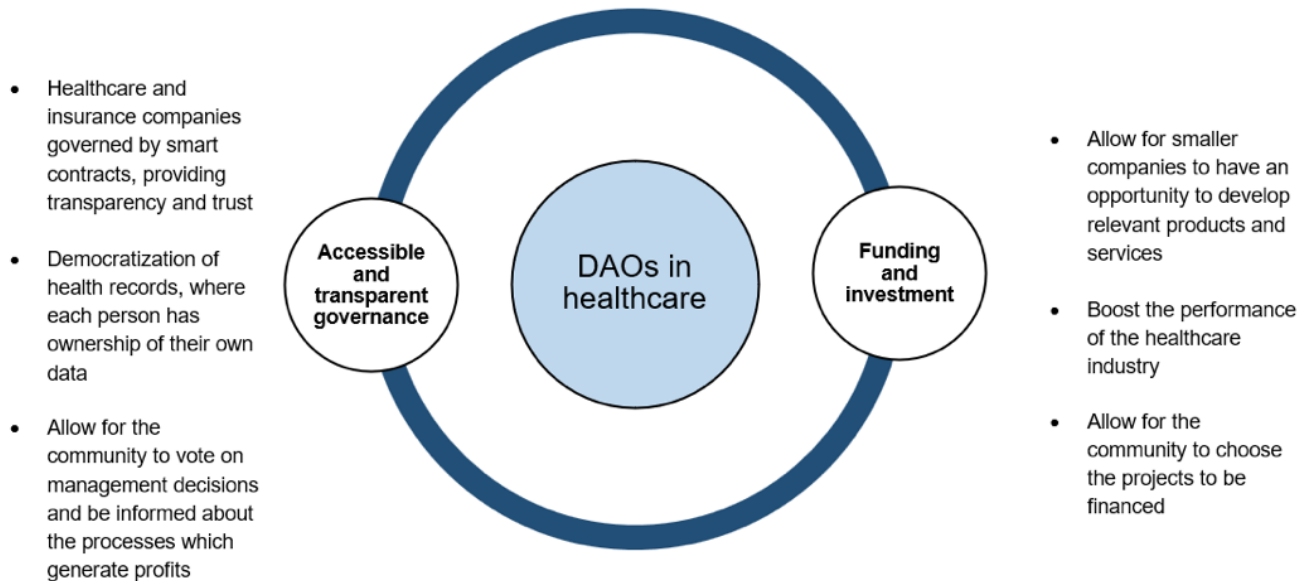
Figure 1 - Opportunities for DAOs in the healthcare field

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