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Editorial: Blockchain and distributed ledger technology—enabled architectures for improving healthcare

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Editorial on the Research Topic
Blockchain and distributed ledger technology—enabled architectures for improving healthcare

The interest in blockchain and Distributed Ledger Technologies (DLT) among health and healthcare research/practice communities has experienced rapid growth in recent years. These technologies are currently being explored in different parts of the world for a diverse array of topics (Zhang and Boulos, 2020; Zhang et al., 2020; Kuo et al., 2021, 2023; Zhang and Kuo). These areas include but are not limited to securing patient/provider identities, establishing secure health data repositories, maintaining a single source of truth, overseeing pharmaceutical and medical device supply chains, detecting medical fraud, enabling secure medical data sharing among researchers, fostering collaborative data analysis, exploring research data monetization, crisis mapping and recovery scenarios, integrating blockchain-enabled augmented reality, facilitating research patient recruitment, and even tackling environmental plastic pollution with blockchain reward systems. Given the increasing availability of health data and the advancements in the Internet of Things (IoT), recent research has seamlessly incorporated artificial intelligence into blockchain-powered healthcare applications (Kuo and Pham, 2022; Zhang and Kamel Boulos, 2022). Although many blockchain use cases in healthcare have been identified, a notable gap persists in the availability of reproducible architectures and prototypes coupled with pragmatic designs.

Meanwhile, recent developments in blockchain and DLT have enabled much more sophisticated computing in a decentralized manner. Blockchain-based architectures, with crucial inherent technical attributes such as immutability and transparency, hold the potential to revolutionize the healthcare industry in multifaceted ways. Their application has the capability to address pressing challenges in healthcare, notably in data sharing interoperability, medical supply chain management, accurate patient identity matching, and various other critical healthcare services (Zhang and Kuo, 2021; Zhang and Kuo). While the demand for interoperable solutions remains substantial, it is important to acknowledge that blockchain and associated DLTs face their own limitations in data privacy, security, and scalability. Therefore, the primary objective of this Research Topic is to include research

studies of blockchain- or DLT-powered designs that will improve healthcare practices, processes, systems, and eventually patient outcomes while overcoming those technical limitations.

Within this Research Topic, the authors have studied several timely and pivotal avenues of inquiry. First, Thakur et al. explored different generations of blockchain, challenges inherent in healthcare applications, and potential remedies based on the utility of blockchain technologies, from the healthcare industry perspective. Alongside the investigation of different blockchain and DLT healthcare applications, this study also discussed the latest trends and factors driving the need to integrate blockchain/DLT into the healthcare sector. Continuing this trajectory, Westphal and Seitz et al. reviewed current research on blockchain implementations in healthcare for three use cases: secure storage for medical records, access to medical data with permission management, and health asset tracking within supply chains. This work identified two important needs for blockchain—secure storage and easy access to complete patient data—and revealed the trend of hybrid solutions as well as the automated processes enabled by smart contracts. Next, Ho et al. proposed a novel blockchain-supported Massive Group Insurance (MGI) model, aiming at reducing the costs of orphan drugs for rare diseases and avoiding adverse selection. The key idea is to leverage blockchain for improving orphan drug data traceability and authentication as well as facilitating effective intellectual property rights payments, to ensure data security at a relatively low administrative overhead, and to support the concept of group insurance to finance and increase the use of orphan drugs. This insurance model also exhibits extensibility beyond orphan drugs to expensive drugs and vaccines, thereby lending support to patient care, drug development, clinical research, and public policy. Finally, Zhang et al. focused on addressing the challenge of lacking design recommendations in blockchain and DLT development for the healthcare sector. Specifically, the study introduced a concrete collection of architectural blockchain design patterns, as well as healthcare domain-specific considerations, to foster secure and scalable health data sharing and exchange. Considering the requirements of both healthcare systems and blockchain solutions, seven novel software design patterns (i.e., Layered Ring, Guarded Update, Contract Manager, Database Connector, Database Proxy, Entity Registry, Tokenized Exchange, and Publisher-Subscriber) were proposed to mitigate the concerns while developing Decentralized Applications (DApps).

On one hand, from the studies in this Research Topic, the authors shed light on the benefits of adopting blockchain and DLT in healthcare as decentralization, immutability, transaction traceability, provenance establishment, enhanced security measures, uninterrupted availability, and programmability via smart contracts. On the other hand, potential areas to improve blockchain adoption include understanding the implications of associated costs, achieving clarity in domain-specific regulations and policies, harnessing technological advancements, encouraging organizational incentives, addressing scalability challenges, and mitigating the storage and communication overhead. Looking ahead, the trajectory of progress hints at the promising rise of reproducible architectures and prototypes rooted in the foundation of blockchain and DLT. These innovative frameworks will transcend theoretical boundaries with practical designs, which will serve as catalysts for a profound and transformative paradigm shift within the healthcare industry.

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