Blockchain in healthcare, research, and scientific publishing

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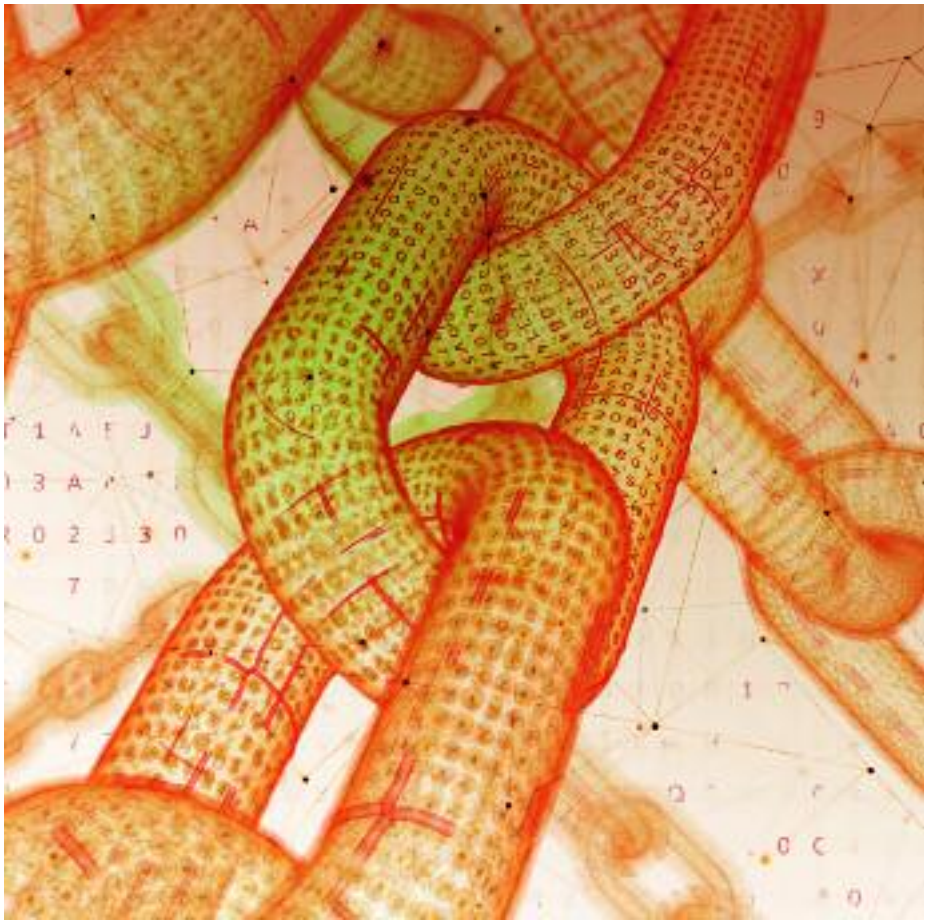
Abstract
Data are being transmitted and stored on cloud-based networks, including clinical, research, and publishing data. These cloud-based systems often lack comprehensiveness, accessibility, interoperability, confidentiality, accountability, and flexibility, which can cause delays for medical treatments, slowed research projects, and general inefficiencies. The advent of blockchain-based technologies provides a reliable solution to ensure that data storage and access are standardised and transparent, independent of a trusted third party. It is not a new stand-alone system, but a layer of trust between the data and users that can integrate with other emerging technologies and optimise their impact. It is rapidly advancing in financial and supply chain industries and now being explored successfully in many applications across the healthcare industry. When applied in medical publishing, blockchain may serve to remedy data sharing and intellectual property issues that often confront medical writers, though implementing this new technology will have some hurdles. In this article, we highlight some selected blockchain-related projects relevant to medical writers.

Blockchain – The basics
Information and data are stored online by companies that guarantee trust and security (e.g banks). This information can include email addresses, names, financial information, and more. Despite these companies doing everything they can to protect this data, nothing can be definitively safe from hackers, mainly because the information is stored in one central place in the form of a computer. This data centralisation makes it easier to steal information – but blockchain works differently.



Blockchain technology is a way to record information (in "blocks") onto many devices (forming a "chain") all at once using the internet, and the type of information is not limited: blockchain can store money, data, music, agreements between individuals, and more. The anonymous individual or group known as Satoshi Nakamoto developed the Bitcoin blockchain in 2009 as a peer-to-peer electronic cash system[1] based on early work by Stuart Haber and Scott Stornetta.[2] Unlike a traditional cloud-based system, blockchain is a decentralised (i.e. no central point, making it more difficult to break into a single device and steal information), distributed ledger of digital transactions that allows the exchange of data.

Through blockchain, data can be managed and organised in a new way: the data are open, permanent, verified and shared, and without the need of a central authority. Given that most industries could benefit from such a system, the application of blockchain technology is being explored for managing a variety of digital assets, such as medical records and research data, which touches the industries that are relevant to medical writers (i.e. publishing, healthcare , and research).

The parallels between blockchain technology and the core needs of the modern healthcare industries are apparent.[3–5] For example, the ability of blockchain to create records of transactions that cannot be altered is valuable for healthcare supply chains. From the factory to a patient, information about drug shipments could be stored in the blockchain (i.e. temperature, price, dispensed to whom, etc), which would

Table 1. Selected blockchain projects in scientific publishing

Journal/organisation	Description
Ledger[7]	The first journal focused exclusively on blockchain and the first to apply the technology to the publishing process. *Ledger* was recently awarded the University of Pittsburgh Cyber Accelerator Grant to help develop the journal and expand its capabilities.
Blockchain in Healthcare Today[8]	The first journal focused on blockchain applications in health, including the health research that underlies the evidence base of medicine. The journal's publisher hosted an expansive conference at Columbia University last fall and made the content available in a special podcast issue. [9]
Journal of the British Blockchain Association[10]	The first blockchain journal aligned with a professional society, it is focused on bringing scientific rigour to blockchain across industries.
Frontiers in Blockchain [11]	The first legacy scientific publisher to devote a title to blockchain. Frontiers has started a new section, *Blockchain for Science* [12] that specifically looks at applications across the science process.
Digital Science[13]	Digital Science and their publishing associate Nature Publishing have teamed up with several other universities and publishers to apply blockchain technology to their publishing process.

improve safety (by allowing for more transparent documentation of each step of the drug development process) and minimise fraud. In a research setting, lab notebooks and records could be more easily and transparently managed (as the data would be accessible by everyone), and publishing processes could also be optimised.

There is no shortage of projects where blockchain could be implemented to increase efficiencies. In Estonia, for example, every citizen's health record is secured with blockchain technology, giving citizens control over their individual health records.[6] Blockchain could also be used to support initiatives such as the UK's National Institute for Health and Care Excellence (NICE) and National Health Service digital frameworks for evaluation, both requiring a great deal of record keeping and data exchange. Other ideas for implementing blockchain include pharmaceutical supply chain, medical device cybersecurity, organ tracking in the transplant setting, medical claims and billing management, tracking of health wearables data, and improving public health data security.

Current blockchain projects

Scientific publishing

Communication is paramount for scientific research, which depends on the exchange of ideas, hypotheses, data, results – and eventually – publications. Research data and discussions is often exchanged through a variety of mediums, across geographies, and between universities and private companies. As such, the scientific enterprise relies on researchers themselves to report on their successes and failures to preserve resources – though this is rarely what happens. Several journals have already started to pave the way for advances in blockchain, both as subject matter and internal tool, in an effort to eventually bridge these gaps (Table 1).

Professional societies and non-profits

Non-profit organisations play a critical role in science. Their movements can often be steady and deliberative, but the involvement of these established entities provides neutral standards (compared to universities and industry stakeholders), long-term vision, and commitment to projects. They can also serve as an industry consortium facilitator to promote collaboration. Some of these are listed in Table 2.

Table 2. Selected blockchain professional societies and non-profits

Organisation	Description
HIMSS Blockchain Task Force[14]	The largest health informatics society has gone from just a panel on blockchain HIMSS2018 to a full day pre-conference symposium and multiple conference sessions in 2019 with more expected in 2020, including research. HIMSS and CRC Press released a text book in early 2019 on Blockchain in Healthcare that includes several chapters on research applications.[15]
IEEE Blockchain for Clinical Trials[16]	One of the largest professional societies in the world held two conferences on Blockchain for Clinical Trials in 2018 in the US and Europe. IEEE is developing standards for clinical trials alongside supply chain standards.
IEEE Standards Association[17]	The standards arm of IEEE has launched a 2-year, open effort, 2418.6 – Standard for the Framework of Distributed Ledger Technology use in Healthcare and the Life and Social Sciences, including a subcommittee focused on research.
Blockchain in Healthcare Global[18]	IEEE International Standards & Technical Organization – This 501(c)(6) trade association under the IEEE/ISTO umbrella includes a focus on health research.

Abbreviation: IEEE, The Institute of Electrical and Electronics Engineers; ISTO, Industry Standards and Technology Organization; HIMSS, Healthcare Information and Management Systems Society

Pharmaceutical industry and biotech

Not only are ten of the largest public companies in the world exploring blockchain,[19] many biotech companies and pharmaceutical companies are too, though mostly behind closed doors – keeping business secrets heavily protected. Deloitte surveys have estimated that nearly 35% of life science companies had planned to deploy blockchain technologies in 2017, and 17% of respondents were already using blockchain (Table 3).[20]

Why is blockchain difficult to implement?

As with many new technologies, particularly related to healthcare or research, blockchain-based advances have been enthusiastically promoted but have been difficult to realise. Evidence-based practice, patient safety, and legal compliance regulations do not encourage accelerated innovation. Another hurdle is the high energy consumption required for digitally signing a secure, permanent record. Additionally, data stored in public chains are not private, and patient data could be at a theoretical risk, although cloud-based storage also has these risks, albeit to a greater extent. Further, by virtue of the technology, data stored in the blockchain cannot be deleted, which could conflict with the EU General Data Protection Regulation,[23] whereby patients must be able to opt out of the storage and use of their data in some circumstances. However in many cases, the personal data itself is not stored on a blockchain, only an encrypted hash (or code) linked to that personal data, which mitigates GDPR-related concerns. Finally, companies, research groups, and publishers are known to be competitive rather than collaborative, which generally slows advancement and hinders implementation of new technologies like blockchain.

Implications of blockchain for medical writers

Medical writers often liaise with various stakeholders to complete a project: from statisticians to key opinion leaders, healthcare providers, and scientists. While working in these teams, writers need to gather feedback, and then merge these into one cohesive draft. By using blockchain, writers (and all other stakeholders) could have permissioned access to these data, drafts, and publications in real-time, with time-stamping for contribution and a shared ledger of changes for all parties to see. Further, the systems used to develop publications can differ widely between clients. Maintaining an archive of these publications' records can become a giant task in its own right. If the industries where medical writers are typically employed (healthcare, research, and publishing) started to use standardised, blockchain-based systems, these issues could be addressed. Further, successful discovery, design, and testing of applications can benefit from medical writers being engaged early in the process. This will enable potential solutions to improve current workflows rather than creating something entirely new that goes unused or forces uncomfortable change. As these new technologies are developed, it is up to medical writers (and all stakeholders) to maintain an accepting willingness to implement new ideas.

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Conflicts of interest

JLJ serves as a review editor for *Blockchain for Science* and has received consulting fees from Novartis.

STM is the CEO of Science Distributed. He also serves without compensation on the board of Blockchain in Healthcare Global, as member and research subcommittee chair of the IEEE standards group 2418.6, as co-chief editor for *Blockchain for Science*, as review editor at *Ledger* and *Journal of the British Blockchain Association*, and on the HIMSS Blockchain Taskforce and HIMSS2020 Blockchain Symposium planning committee and chapter author of HIMSS series textbook.

Table 3. Selected blockchain projects in the scientific/pharmaceutical industry

Organisation	Description
Wolfram Alpha[21]	One of the top names in research statistics has been exploring how to develop a framework that can be used for all of scientific research.
Science Distributed[22]	A small firm providing support to university and federal clients to identify use cases and design blockchain solutions at the network level for better health research.
Novartis[23]	One of many large pharmaceutical companies exploring a variety of ways to use the blockchain, including the IMI Blockchain Enabled Healthcare Program.
Chronicled, Inc & The MediLedger Project[24]	Pfizer, Genetech, McKesson Corporation, Amerisource Bergen Corporation, Premier Inc and other pharmaceutical giants have joined up to use blockchain for supply chain management.
Innovative Medicines Initiative (IMI)[25]	The IMI is a public-private partnership between the EU and the European pharmaceutical industry represented by The European Federation of Pharmaceutical Industries and Associations, a Brussels-based trade association. For the Blockchain Enabled Healthcare program, the IMI is earmarked up to €18 million, which was expected to last three years.



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References

1. Nakamoto S. Bitcoin: A Peer-to-Peer Electronic Cash System 2009 [Internet]. [cited 2019 Oct 30]. Available from: www.bitcoin.org.
2. Oberhaus D. The World's Oldest Blockchain Has Been Hiding in the New York Times Since 1995. Motherboard: Tech by Vice [Internet]. 2018. [cited 2019 Oct 30] Available from: https://www.vice.com/en_us/article/j5nzx4/what-was-the-first-blockchain.
3. Fan K, Wang S, Ren Y, Li H, Yang Y. MedBlock: Efficient and secure medical data sharing via blockchain. J Med Syst. 2018;42(8):136.
4. Li H, Zhu L, Shen M, Gao F, Tao X, Liu S. Blockchain-based data preservation system for medical data. J Med Syst. 2018;42(8):141.
5. Radanovic I, Likic R. Opportunities for use of blockchain technology in medicine. Appl Health Econ Health Policy. 2018;16(5):583–90.
6. Leeming G, Ainsworth J, Clifton DA. Blockchain in health care: hype, trust, and digital health. Lancet. 2019;393(10190):2476–7.
7. Ledger Journal. Pittsburgh, PA (USA): University of Pittsburgh. Vol 1, 2016–
8. Blockchain in Healthcare Today. Stamford, CT (USA): Partners in Digital Health. Vol 1, 2018–
9. Blockchain in Healthcare Today Podcasts [Internet]. [cited 2019 Oct 30] Available from: https://blockchainhealthcaretoday.com/ index.php/journal/issue/view/2.
10. The British Blockchain Association London (UK): Kemp House. Vol 1, 2018–
11. Frontiers in Blockchain [Internet]. [cited 2019 Oct 30] Available from: https://www.frontiersin.org/journals/blockchain#.
12. Blockchain for Science [Internet]. [cited 2019 Oct 30] Available from: https://www.frontiersin.org/journals/blockchain/sections/blockchain-for-science#.
13. Digital Science [Internet]. [cited 2019 Oct 30] Available from: https://www.digital-science.com/.
14. HIMSS Blockchain in Healthcare [Internet]. [cited 2019 Oct 30] Available from: https://www.himss.org/library/blockchain-healthcare.
15. Dhillon V, Bass J, Hooper J, Metcalf D, Cahana A. Blockchain in Healthcare: Innovations that Empower Patients, Connect Professionals and Improve Care. 1st Edition ed: CRC Press Taylor and Francis Group; 2019 January 25, 2019.
16. IEEE Blockchain for clinical trials program [Internet]. [cited 2019 Oct 30] Available from: https://blockchain.ieee.org/standards/clinicaltrials.
17. IEEE Blockchain Standards [Internet]. [cited 2019 Oct 30] Available from: https://blockchain.ieee.org/standards.
18. Blockchain in Healthcare Global [Internet]. [cited 2019 Oct 30] Available from: https://ieee-isto.org/member_programs/blockchain-in-healthcare-global/.
19. Castillo Md. Forbes [Internet]. [cited 2019 Oct 30] Available from: https://www.forbes.com/sites/michaeldelcastillo/2018/07/03/big-blockchain-the-50-largest-public-companies-exploring-blockchain/.
20. Deloitte Survey: Buillding up Blockchain[Internet]. [cited 2019 Oct 30] Available from: https://www2.deloitte.com/content/dam/Deloitte/si/Documents/about-deloitte/16%20US%20Innovation%20Blockchain%20Infographic_FINAL.pdf.
21. Wolfram Blockchain Labs [Internet]. [cited 2019 Oct 30] Available from: https://www.wolframblockchainlabs.com/.
22. Science Distributed [Internet]. [cited 2019 Oct 30] Available from: https://sciencedistributed.com/.
23. Morris N. Ledger Insights: Enterprise blockchain news [Internet]. [cited 2019 Oct 30] Available from: https://www.ledgerinsights.com/novartis-pharma-blockchain/.
24. The MediLedger Project [Internet]. [cited 2019 Oct 30] Available from: https://www.mediledger.com/.
25. IMI Blockchain Enabled Healthcare [Internet]. [cited 2019 Oct 30] Available from: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/imi2-2018-15-02.

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