Future Healthcare Journal 11 (2024) 100005

Contents lists available at ScienceDirect

Future Healthcare Journal

journal homepage: https://www.sciencedirect.com/journal/future-healthcare-journal

Blockchain: What is the use case for physicians in 2024? A rapid review of the literature

Aqib Arif[a,*], Mureed Hussain[a], Christian P Subbe[a,b]

[a] Department of Medicine Ysbyty Gwynedd, Bangor, UK
[b] School of Medical Sciences, Bangor University, Bangor, UK

ARTICLE INFO

Keywords:
Blockchain
Clinical medicine
Hospital

ABSTRACT

Blockchain is topical in many areas of science. The impact on clinical care of physicians is not known.
We undertook a rapid review of the literature to identify areas of interest for clinicians in active practice focusing on evidence relevant to clinical care.
We found limited evidence for use blockchain in clinical practice with most studies focusing on technical aspects of prototypes and implementation with no evidence of standardised metric to measure impact for patients, clinicians, and organisations. Personal Health Records for use across organisational and geographic boundaries emerged as the strongest clinical use-case.
Defined metrics by professional bodies might aid research, development, and future impact.

Introduction

Blockchain is a decentralised, distributed ledger[1]: At its core, it consists of a chain of blocks of data, each containing a list of transactions. What sets blockchain apart is its decentralised nature—instead of relying on a central authority, it operates on a network of computers (nodes) that reach consensus through algorithms. Transactions in a block of data are secured through cryptography, and each block is linked to the previous one, forming an unalterable chain. This creates a transparent and tamper-resistant ledger, as altering one block would require changing every subsequent block, a computationally infeasible task. Blockchain has diverse applications including smart contracts and self-executing agreements with coded rules. As blockchain has impacts on immutability, decentralisation, and data transparency in their area of application, it is being used in an exploding number of industries. While cryptocurrencies and Non-Fungible Tokens are capturing the public imagination medical researchers are investigating multiple applications for this new technology.

This paper aims to summarise evidence relevant to practising physicians.

Methods

We undertook a rapid review of the literature[2,3] using Medline, AMED, PsychInfo, HMIC and Embase and two reviewers (AA, CPS). The search terms were generated in an interactive fashion by a peer group of junior and senior physicians and revised by a research librarian. The protocol for the search was not registered.

Setting: clinical work by physicians and internists.

Inclusion criteria: applications available for clinical use as part of routine practice or used as part of clinical trials.

Exclusion criteria: applications that have not been tested for clinical care with actual patients or clinicians. Use of blockchain in applications limited to use outside of clinical areas. The search was not limited by geography of the application.

Search terms were generated by combination of terms including 'blockchain' and MESH terms including 'hospital', 'emergency'. ((("Hospital Medicine"[Mesh]) OR "Emergencies"[Mesh]) OR "Health Records, Personal"[Mesh]) AND "Blockchain"[Mesh]. Searching of references was used identified further manuscripts.

The search was run on 18 May and re-run by a research librarian on 23 October 2023.

Included manuscripts were discussed by the three authors and the relevance for current practice was summarised as part of the data extraction form.

No funding was received for the rapid review of the literature.

Results

The searches returned 241 citations for which we reviewed article abstracts. A further six articles were identified through other sources. Of these manuscripts, six fulfilled the inclusion criteria and were reviewed

This article reflects the opinions of the author(s) and should not be taken to represent the policy of the Royal College of Physicians unless specifically stated.

* Corresponding author.
E-mail address: c.subbe@bangor.ac.uk (A. Arif).

https://doi.org/10.1016/j.fhj.2024.100005

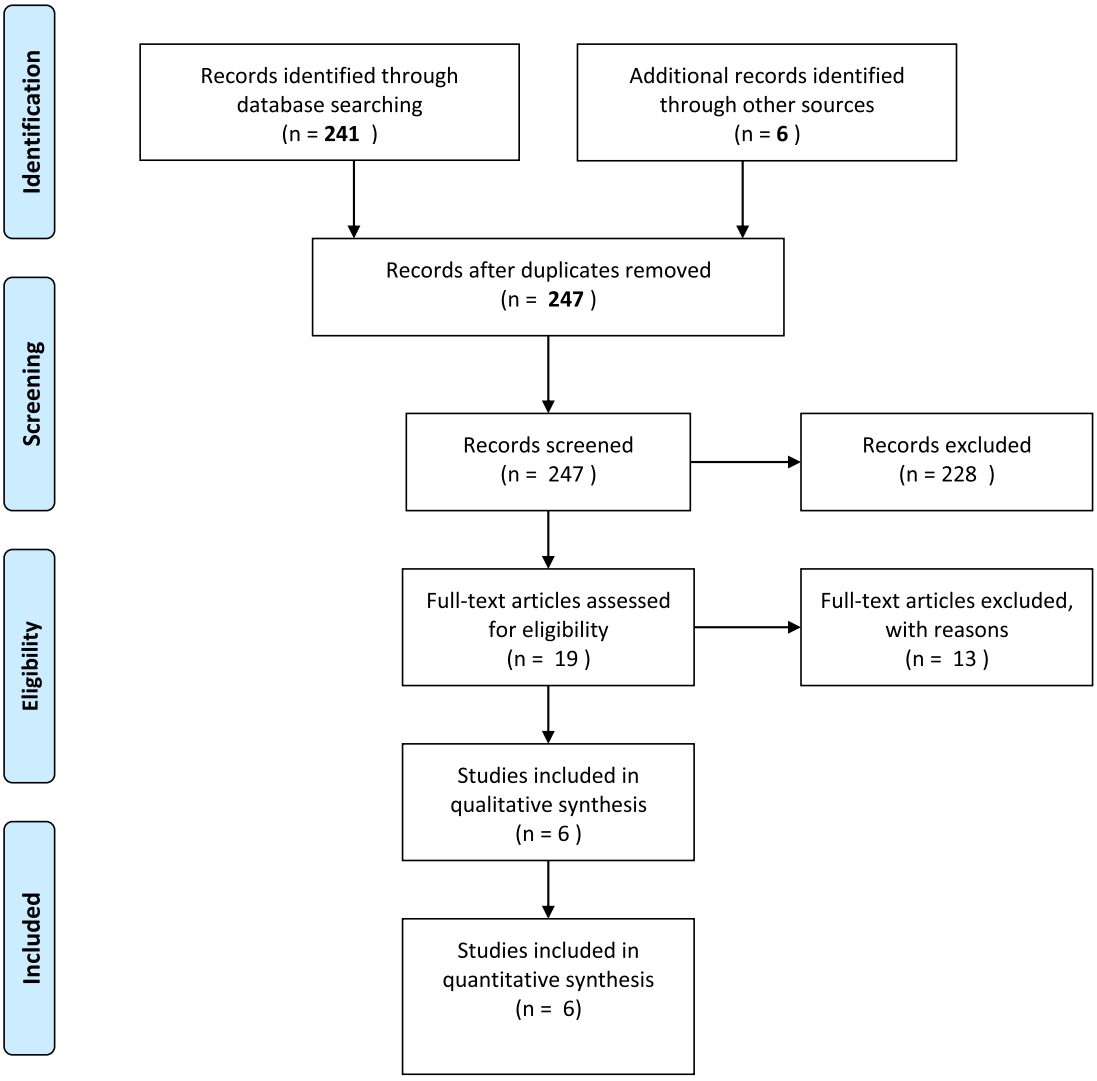

Fig. 1. PRISMA flow diagram of the literature search.
From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta- Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097.

in full (Fig. 1 – PRISMA flow chart). Two articles were from Taiwan, and one each from Japan, Korea, United Kingdom and the United States. All included studies published since 2019.

Study characteristics are summarised in Table 1: four studies were in a research environment[4–7] focusing on feasibility and usability of creating databases and the effectiveness of the system architecture and resilience to simulated attacks on the integrity of data. The other studies were from heterogenous settings including hospital inpatient-, outpatient- and primary care. The number of patients using the blockchain application varied from five to 175 patients.

Five of the manuscripts used blockchain for personal health records or mHealth applications. Only one study included a control to the intervention.[8]

The excluded materials failed to meet the inclusion criteria mostly due to their lack of testing in clinical environment and use with clinicians or patients.

Clinical conditions included patients with insomnia[5] and diabetes[8] but description of patient population lacked detail in most publications.

Outcome metrics was mostly focused around utilisation[9] or technical feasibility.[4] Patient facing metric included Likert scales on confidence of users.[8]

Lee et al[4] tested a prototype with the aim of measuring effectiveness and feasibility of architecture based on blockchain for personal health records (PHR) is. Similar to Motohashi[5] they established that the system is effective for sharing information between different organisations and individuals. Lo et al[10] implemented a blockchain enabled record that was used for pathology reports, discharge notes, and health check reports. The focus of the study focused on feasibility, but patients used the application.

Risks of the technology were not part of the evaluation in most papers with one paper focusing on resilience of the technology to attacks.[5]

Discussion

Our search identified only a small number of studies that used blockchain technology in clinical practice or clinical research. Studies were predominantly from Asian centres and reported on limited numbers of patients. We found little evidence for studies examining impact on outcomes of the quadruple aim[11] such as clinical outcomes, mortality, morbidity, rate of complications, cost or care, patient or staff satisfaction.

We used an explicit research strategy and a research librarian but fast advances in the field might mean that results of search might be quickly outdated. The heterogeneity of chosen study formats and outcome measures precludes a meta-analysis of outcomes. In line with the

Table 1
Summary of study characteristics (PHR: personal health record).

Author (date of publication)	Country	Setting	Study design	Population	Metric	Clinical metric	PHR or mHealth application	Compared to	Main outcome
Despotou et al[8]	United Kingdom	Primary care	Testing a consent form with diabetic patients with interviews and focus groups.	23 Patients, 13 staff (no clinical use)	Likert scale on confidence of users	Patient preferences	Yes	Paper- based consent	Patients favoured app over existing practice.
Glicksberg et al[7]	United States	Research	Feasibility study	18 Patients with cancer	Completeness of data from two EHRs	None	No	N/A	Feasibility of creating a deidentified database for patients with late-stage cancer from a number of data sources.
Lee et al[4]	Taiwan	Research	Prospective testing in research setting.	5 Test patients	Effectiveness and feasibility of system	No	Yes	N/A	Architecture is effective in managing and utilising PHRs.
Lo et al[10]	Taiwan	Teaching hospital & community clinics	Observational study	175 Patients in hospital and community	N/A	Interest by patients	Yes	N/A	Medical referrals made automatically and efficiently.
Motohashi et al[5]	Japan	Research	mHealth app for treatment of insomnia	Unspecified number of patients	Correctness of data	No	Yes	N/A	Successfully registered data with blockchain and resilience to simulated attacks on integrity of the data.
Sung et al[6]	Korea	Research	Usability study	70 Patients from primary care clinics	Usability survey and observation of use: 44 patients logged in more than once	None	Yes	N/A	Satisfactory outcome on a System Usability Scale.

methodology, we did not assess bias. We are concerned about the generalisability of the small number of studies and the low numbers of included patients.

Use of blockchain applications is currently being explored in many settings related to healthcare including supply chain management for medications and joint,[12] back-office functions for verification of educational qualifications,[13] administration of human resources[14] as well as for personal health records.[15]

An authoritative review by the Lancet found that the overwhelming majority of all studies of Blockchain had no or only simulated outcomes, and two of the few clinical study included have since been retracted.[16] Two studies that were included in our initial review of the literature (and the only studies including biomarkers) have since been retracted.[17,18]

The most promising areas for impact would seem those were the 'truth' of information needs to be ascertained and by different providers: health care qualifications,[19] prosthetic parts[20,21] or past medical history and medication of patients[22]. All have in common that at current a cumbersome verification process is required if information is held by different organisations or parts of a larger organisation. While it is the belief of the authors that availability of correct safety critical information is essential for safety and quality of clinical care, more applications in clinical practice are needed to demonstrate impact.

On theoretical grounds alone application of a decentralised data system might have highest clinical utility in health care systems that are decentralised themselves: a monopolistic healthcare provider like the National Health Service might be able to contain all data related to a patient in a single electronic health record. Where patients attend a broad range of providers fragmented information might be a bigger challenge for patients and clinicians.

The biggest gains for clinicians and patients might be made in the field of personal health records for patients at risk of fragmented care, ie, those who receive care by specialists in different organisations,[23] for patients with highly specialised needs, those who are travelling for work or pleasure or seek less pricey specialised care abroad.[24] In patients whose care is fragmented between providers studies should be able to ascertain whether convenience and speed of access to safety critical information through blockchain affects quality and outcomes of care. It would seem essential that study formats and outcome metrics are standardised to make results comparable and accelerate innovation and impact.

Despite the enormous promise of the technology there appears to be an innovation gap in healthcare compared to other industries. While our search revealed limited evidence, the cost of digital health might limit availability in resource limited environments and in areas with high deprivation as well as for patients with limited digital literacy. Wider spread of Electronic Health Records in countries such as the United States, Sweden or Taiwan might make blockchain application a more attractive value proposition.

Conclusion

Blockchain technology is rapidly developing as a key enabler for data security and decentralised information systems. Despite this the impact on work undertaken by clinicians or patients working in hospital medicine or emergency care is as yet small. Funders, policy makers and professional bodies might aid impactful implementation by specifying key metrics.

Appendix 1. Extended search algorithm

Database: AMED (Allied and Complementary Medicine) <1985 to October 2023>, Embase <1996 to 2023 October 20>, APA PsycInfo <2002 to October Week 3 2023>, HMIC Health Management Informa-

tion Consortium <1979 to September 2023>, Ovid MEDLINE(R) ALL <1946 to October 20, 2023>

Search Strategy:

1. exp Blockchain/ (1624)
2. blockchain.mp. (3832)
3. 1 or 2 (3832)
4. exp Physicians/ (1173046)
5. physician$.mp. (1479832)
6. clinician$.mp. (840714)
7. clinical care.mp. (78538)
8. exp Hospital Medicine/ (2309)
9. hospital medicine.mp. (6425)
10. exp Emergency Service, Hospital/ or hospital emergency.mp. or exp Emergency Medical Services/ (488188)
11. (accident and emergency).mp. [mp=ab, hw, ti, tn, ot, dm, mf, dv, kf, fx, dq, tc, id, tm, bt, nm, ox, px, rx, ui, sy, ux, mx] (57669)
12. a & e.mp. [mp=ab, hw, ti, tn, ot, dm, mf, dv, kf, fx, dq, tc, id, tm, bt, nm, ox, px, rx, ui, sy, ux, mx] (24180)
13. (a and e).mp. [mp=ab, hw, ti, tn, ot, dm, mf, dv, kf, fx, dq, tc, id, tm, bt, nm, ox, px, rx, ui, sy, ux, mx] (1737238)
14. 4 or 5 or 6 (2802166)
15. 7 or 8 or 9 or 10 or 11 or 12 or 13 (2328673)
16. 3 and 14 and 15 (13)
17. phr.mp. (4137)
18. personal health record.mp. [mp=ab, hw, ti, tn, ot, dm, mf, dv, kf, fx, dq, tc, id, tm, bt, nm, ox, px, rx, ui, sy, ux, mx] (1763)
19. exp Health Records, Personal/ (312715)
20. 17 or 18 or 19 (316425)
21. 3 and 20 (262)
22. 16 or 21 (274)
23. remove duplicates from 22 (244)
24. 24 from 23 keep 2-6,9-13,17,19-21,23-25,28-38,42-48,50-52,54,56,58,61-63,66-68,70-71,73,75,77-79,83,85-86,88,90-92,94-96,98,100-105,107-108,110-113,115-117,122,124,129,131-132,138-139,141-142,144-145,148-151,154-156,158-163,165-166,169,179,182,186,189-193,197,199,201,206,208,210-212,216,218,222-223,230-231,233-234,237,239 (133)

References

1. López-Sorribes S, Rius-Torrentó J, Solsona-Tehàs FA. Bibliometric review of the evolution of blockchain technologies. *Sensors*. 2023;23(6):3167.
2. Khangura S, Konnyu K, Cushman R, Grimshaw J, Moher D. Evidence summaries: the evolution of a rapid review approach. *Syst Rev*. 2012;1(1):10.
3. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J*. 2009;26:91–108.
4. Lee HA, Kung HH, Udayasankaran JG, *et al.* An architecture and management platform for blockchain-based personal health record exchange: development and usability study. *J Med Internet Res*. 2020;22(6):1–15.
5. Motohashi T, Hirano T, Okumura K, Kashiyama M, Ichikawa D, Ueno T. Secure and scalable mhealth data management using blockchain combined with client hashchain: system design and validation. *J Med Internet Res*. 2019;21(5):e13385.
6. Sung MD, Park SJ, Jung S, Lee E, Lee J, Park YR. Developing a mobile app for monitoring medical record changes using blockchain: development and usability study. *J Med Internet Res*. 2020;22(8):e19657.
7. Glicksberg BS, Burns S, Currie R, *et al.* Blockchain-authenticated sharing of genomic and clinical outcomes data of patients with cancer: a prospective cohort study. *J Med Internet Res*. 2020;22(3):e16810.
8. Despotou G, Evans J, Nash W, Eavis A, Robbins T, Arvanitis TN. Evaluation of patient perception towards dynamic health data sharing using blockchain based digital consent with the Dovetail digital consent application: a cross sectional exploratory study. *Digit Heal*. 2020;6:1–11.
9. Chelladurai MU, Pandian DS, Ramasamy DK. A blockchain based patient centric electronic health record storage and integrity management for e-Health systems. *Heal Policy Technol*. 2021;10(4):100513.
10. Lo YS, Yang CY, Chien HF, Chang SS, Lu CY, Chen RJ. Blockchain-enabled iWellChain framework integration with the national medical referral system: development and usability study. *J Med Internet Res*. 2019;21(12):1–13.
11. Sikka R, Morath JM, Leape L. The quadruple aim: care, health, cost and meaning in work. *BMJ Qual Saf*. 2015;24(10):608–610.
12. Teodorescu M, Korchagina E. Applying blockchain in the modern supply chain management: its implication on open innovation. *J Open Innov Technol Mark Complex*. 2021;7:80.
13. Naqvi N, Hussain M. Medical education on the blockchain. *J Br Blockchain Assoc*. 2018;1(2):1–5.
14. Yi CSS, Yung E, Fong C, Tripathi S. Benefits and use of blockchain technology to human resources management: a critical review. *Int J Hum Resour Stud*. 2020;10(2):131140.
15. Fang HSA, Tan TH, Tan YFC, Tan CJM. Blockchain personal health records: systematic review. *J Med Internet Res*. 2021;23(4):e25094.
16. Ng WY, Tan TE, Movva PVH, *et al.* Blockchain applications in health care for COVID-19 and beyond: a systematic review. *Lancet Digit Heal*. 2021;3(12):e819–e829.
17. Niu Y. Influence of standardized nursing management of hospital based on smart electronic medical blockchain on nursing quality of digestive endoscopy room. *J Healthc Eng*. 2021;2021:5539901.
18. Liu Y, Yu Z, Sun H. Treatment effect of Type 2 diabetes patients in outpatient department based on blockchain electronic mobile medical app. *J Healthc Eng*. 2021;2021:6693810.
19. Pauletto C. Blockchain in international e-government processes: opportunities for recognition of foreign qualifications. *Res Glob*. 2021;3:100034.
20. Thomson C, Beale R. Is blockchain ready for orthopaedics? A systematic review. *J Clin Orthop Trauma*. 2021;23:101615.
21. Ghimire T, Joshi A, Sen S, Kapruan C, Chadha U, Selvaraj SK. Blockchain in additive manufacturing processes: recent trends & its future possibilities. *Mater Today Proc*. 2022;50:2170–2180.
22. Radanović I, Likić R. Opportunities for use of blockchain technology in medicine. *Appl Health Econ Health Policy*. 2018;16(5):583–590.
23. Naqvi N. Interview with Chrissa McFarlane. *J Br Blockchain Assoc*. 2018;1(2):1–4.
24. Pilkington M. The relation between tokens and blockchain networks: the case of medical tourism in the Republic of Moldova. *J Br Blockchain Assoc*. 2020;4(1):1–11.