

## Documents

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**Generic Patient-Centered Blockchain-Based EHR Management System**

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**Abstract**

Accessing healthcare services by several stakeholders for diagnosis and treatment has become quite prevalent owing to the improvement in the industry and high levels of patient mobility. Due to the confidentiality and high sensitivity of electronic healthcare records (EHR), the majority of EHR data sharing is still conducted via fax or mail because of the lack of systematic infrastructure support for secure and reliable health data transfer, delaying the process of patient care. As a result, it is critically essential to provide a framework that allows for the efficient exchange and storage of large amounts of medical data in a secure setting. The objective of this research is to develop a Patient-Centered Blockchain-Based EHR Management (PCEHRM) system that allows patients to manage their healthcare records across multiple stakeholders and to facilitate patient privacy and control without the need for a centralized infrastructure by means of granting or revoking access or viewing one's records. We used an Ethereum blockchain and IPFS (inter-planetary file system) to store records because of its advantage of being distributed and ensuring the immutability of records and allowing for the decentralized storage of medical metadata, such as medical reports. To achieve secure a distributed, and trustworthy access control policy, we proposed an Ethereum smart contract termed the patient-centric access control protocol. We demonstrate how the PCEHRM system design enables stakeholders such as patients, labs, researchers, etc., to obtain patient-centric data in a distributed and secure manner and integrate utilizing a web-based interface for the patient and all users to initiate the EHR sharing transactions. Finally, we tested the proposed framework in the Windows environment by compiling a smart contract prototype using Truffle and deploy on Ethereum using Web3. The proposed system was evaluated in terms of the projected medical data storage costs for the IPFS on blockchain, and the execution time for a different number of peers and document sizes. The findings of the study indicate that the proposed strategy is both efficient and practicable. © 2023 by the authors.

**Author Keywords**

blockchain; health record; IPFS; patient-centered; privacy

**References**

- Madine, M.M., Battah, A.A., Yaqoob, I., Salah, K., Jayaraman, R., Al-Hammadi, Y., Pesic, S., Ellahham, S.  
**Blockchain for giving patients control over their medical records**  
(2020) *IEEE Access*, 8, pp. 193102-193115.
- Idrees, S., Nowostawski, M., Jameel, R., Mourya, A.  
**Security Aspects of Blockchain Technology Intended for Industrial Applications**  
(2021) *Electronics*, 10.
- Sharma, A., Tomar, R.S., Chilamkurti, N., Kim, B.G.  
**Blockchain Based Smart Con- tracts for Internet of Medical Things in e-Healthcare**  
(2020) *Electronics*, 9.
- Saidi, H., Labraoui, N., Ari, A.A., Maglaras, L.A., Emati, J.H.  
**DSMAC: Privacy-aware Decentralized Self-Management of data Access Control based on blockchain for health data**  
(2022) *IEEE Access*, 10, pp. 101011-101028.
- Makridakis, S., Christodoulou, K.  
**Blockchain: Current challenges and future pro-spects/applications**  
(2019) *Future Internet*, 11.

- Seh, A.H., Zarour, M., Alenezi, M., Sarkar, A.K., Agrawal, A., Khan, A.R.  
**Healthcare Data Breaches: Insights and Implications**  
(2020) *Healthcare*, 8.
- Azaria, A., Ekblaw, A., Vieira, T., Lippman, A.  
**Medrec: Using blockchain for medical data access and permission management**  
*Proceedings of the 2016 2nd International Conference on Open and Big Data (OBD)*, pp. 25-30.  
IEEE, Vienna, Austria, 22–24 August 2016
- Ivan, D.  
**Moving toward a blockchain-based method for the secure storage of patient records**  
*Proceedings of the ONC/NIST Use of Blockchain for Healthcare and Research Workshop, ONC/NIST*,  
Gaithersburg, MD, USA, 4 August 2016
- Dannen, C.  
(2017) *Introducing Ethereum and Solidity*,  
Springer, Berlin/Heidelberg, Germany
- Shen, B., Guo, J., Yang, Y.  
**Medchain: Efficient healthcare data sharing via blockchain**  
(2019) *Appl. Sci*, 9.
- Jamil, F., Ahmad, S., Iqbal, N., Kim, D.-H.  
**Towards a remote monitoring of patient vital signs based on iot-based blockchain integrity management platforms in smart hospitals**  
(2020) *Sensors*, 20.
- Margheri, A., Masi, M., Miladi, A., Sassone, V., Rosenzweig, J.  
**Decentralised provenance for healthcare data**  
(2020) *Int. J. Med. Inform*, 141, p. 104197.
- Roehrs, A., da Costa, C.A., da Rosa Righi, R., da Silva, V.F., Goldim, J.R., Schmidt, D.C.  
**Analyzing the performance of a blockchain-based personal health record implementation**  
(2019) *J. Biomed. Inform*, 92, p. 103140.
- Jha, N., Prashar, D., Khalaf, O.I., Alotaibi, Y., Alsufyani, A., Alghamdi, S.  
**Blockchain Based Crop Insurance: A Decentralized Insurance System for Modernization of Indian Farmers**  
(2021) *Sustainability*, 13.
- Dwivedi, A.D., Srivastava, G., Dhar, S., Singh, R.  
**A decentralized privacy- preserving healthcare blockchain for iot**  
(2019) *Sensors*, 19.  
30650612
- Rajput, A., Li, Q., Ahvanooey, M.  
**A blockchain-based secret-data sharing framework for personal health records (2021) in emergency condition**  
(2021) *Healthcare*, 9.  
33672991
- Jagadeesh, R., Mahantesh, K.  
**Blockchain-based knapsack system for security and privacy preserving to medical data (2021) in SN COMPUT**  
(2021) *Scientifur*, 2, p. 245.
- Egala, B.S., Pradhan, A.K., Badarla, V., Mohanty, S.P.  
**Fortified-chain: A blockchain- based framework for security and privacy-assured**

**internet of medical things with effective access control**(2021) *IEEE Internet Things J*, 8, pp. 11717-11731.

- Alsufyani, A., Alotaibi, Y., Almagrabi, A.O., Alghamdi, S.A., Alsufyani, N.  
**Optimized intelligent data management framework for a cyber-physical system for computational applications**  
(2021) *Complex. Intell. Syst*, pp. 1-13.
- Singh, P., Masud, M., Hossain, M.S., Kaur, A.  
**Blockchain and homomorphic encryption- based privacy-preserving data aggregation model in smart grid**  
(2021) *Comput. Electr. Eng*, 93, p. 107209.
- Peng, C., He, D., Chen, J., Kumar, N., Khan, M.K.  
**EPRT: An Efficient Privacy-Preserving Medical Service Recommendation and Trust Discovery Scheme for eHealth System. ACM Trans**  
(2021) *Internet Technol*, 21, pp. 1-24.
- Piao, Y., Ye, K., Cui, X.  
**A Data Sharing Scheme for GDPR-Compliance Based on Consortium Blockchain**  
(2021) *Future Internet*, 13.
- Wood, G.  
*Ethereum: A Secure Decentralised Generalised Transaction Ledger*,  
Available online
- Buterin, V.  
*Ethereum White Paper*,  
Available online
- Dhillon, V., Metcalf, D., Hooper, M.  
(2017) *Blockchain Enabled Applications*,  
Apress, Berkeley, CA, USA
- Foschini, L., Gavagna, A., Martuscelli, G., Montanari, R.  
**Hyperledger Fabric Blockchain: Chaincode Performance Analysis**  
*Proceedings of the ICC 2020—2020 IEEE International Conference on Communications (ICC)*, pp. 1-6.  
Dublin, Ireland, 7–11 June 2020
- Mani, V., Manickam, P., Alotaibi, Y., Alghamdi, S., Khalaf, O.I.  
**Hyperledger healthchain: Patient-centric IPFS-based storage of health records**  
(2021) *Electronics*, 10.
- Kumar, S., Bharti, A.K., Amin, R.  
**Decentralized secure storage of medical records using Blockchain and IPFS: A comparative analysis with future directions**  
(2021) *Secur. Privacy*, 4, p. e162.
- Langer, S.G., Tellis, W., Carr, C., Daly, M., Erickson, B.J., Mendelson, D., Moore, S., Warnock, M.  
**TheRSNA Image Sharing Network**  
(2014) *J. Digit. Imaging*, 28, pp. 53-61.  
25037586
- Fan, K., Wang, S., Ren, Y., Li, H., Yang, Y.  
**MedBlock: Efficient and Secure Medical DataSharing Via Blockchain**  
(2018) *J. Med. Syst*, 42, p. 136.  
29931655

- Xia, Q., Sifah, E.B., Asamoah, K.O., Gao, J., Du, X., Guizani, M.  
**MeDShare: Trust-Less Medical Data Sharing among Cloud ServiceProviders via Blockchain**  
(2017) *IEEE Access*, 5, pp. 14757-14767.
- Lee, W.  
**Getting Started with Smart Contract and using the MetaMask Chrome Extension**  
(2019) *Beginning Ethereum Smart Contracts Programming*,  
Apress, Berkeley, CA, USA

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