



Potential Benefits of Non-Fungible Tokens (NFTs) and Blockchain Technology in Dermatology

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To the Editor,

Imaging has revolutionized dermatology by enabling non-invasive visualization of skin conditions, enhancing diagnostic capabilities, and guiding personalized treatment approaches. A 2015 survey of 153 board-certified dermatologists depicted the prevalence of medical photography with 61.8% reporting everyday use, most frequently in cases of marking biopsy sites (87.5%), tracking disease (82.9%), and for pedagogical purposes (72.4%) [1]. Amidst burgeoning advancements in blockchain technology, there is potential for non-fungible tokens (NFTs) to be utilized in storing dermatologic images securely yet transparently, providing a more efficient and cost-effective option to manage patient health information.

Put simply, NFTs are tradeable assets that represent any number or class of unique digital objects. The NFT's representative reach is limitless: one may mint (or monetize) NFTs of artwork, real estate, and even patient health data. NFTs are non-interchangeable, non-replicable data packets stored on a digital ledger known as a "blockchain." The blockchain platform, most commonly Ethereum, is

a peer-to-peer network of transactions secured by hash functions, which generate verifiable 256-bit signatures for each ledger transaction. Blockchain technology, therefore, permits immutable digital ownership in the form of NFTs. These assets demonstrate early signs of unlocked potential in dermatology, specifically: the health imaging storage and retrieval spaces, wherefore the need for standardization (ie Digital Imaging and Communication in Medicine [DICOM], 'DICODerma' [2]) has drawn considerable interest by the International Skin Imaging Collaboration [3].

The security afforded by cryptographic hash function indicates a role for NFTs in the control of dermatologic patient data. Upwards of 200 million individual electronic health records (EHR) were breached from 2010-2020 in the United States alone [4]. EHR data and e-prescribing software are susceptible to cyberattacks of blackmail and extortion schemes due to stored patient identifiers and financial information (eg "WannaCry" in 2017 and "Ryuk" in 2020). Gandhi and colleagues previously remarked that while paid cloud storage in dermatology (ie Amazon Web Services or Google Cloud) lends increased capacity and privacy with 'zero logs,' concerns remain related to service costs and the

need for a third party to host this data [5]. Continuing, a 2018 cross-sectional questionnaire study of patients with psoriasis reported that 100% (181/181) would like to know where and how their medical data is stored and 96.7% (178/181) agree they should decide who has access to their data [6]. NFTs could replace dated recordkeeping architecture with proof-of-stake (PoS, available on coming Ethereum 2.0) or predecessor Ethereum 1.0 proof-of-work (PoW) protocols. These protocols require the ledger to achieve “distributed consensus,” or a highly robust method validation of the blockchain transaction timeline, rendering the PoS/PoW frameworks immune to most common cyberattack vectors.

In the context of NFTs, cryptographic hashing also offers excellent search ability (owed to constant time complexity ‘O(1)’ and unique indexing IDs), data caching, and data integrity validation (via comparison of hashes to identify data alteration or tampering). Ethereum Keccak-256 cryptographic hash function performs one-way reduction of any-length input data, or “key,” to a fixed length of 256 bits. In other words, transaction IDs added to the Ethereum blockchain – and used to locate exchanges – are represented by a mere 32-byte string. Currently, health systems are at the mercy of state laws mandating retention of medical records up to a decade following the patient’s most recent discharge (see 210 ILCS 85/6.17 (c)). Given additional projections that health systems will generate > 2,000 exabytes of data each year by 2030 [7], the benefits of hashing are becoming increasingly attractive.

Moreover, the blockchain effectively serves as a common storage system (a network of interconnected nodes), providing a solution to the EHR interoperability crisis [8] and significant liability concerns faced by dermatologists in the event of an EHR malfunction or failure [9]. Hospital systems commonly employ multiple incompatible electronic medical record (EMR) vendors across various healthcare settings, demanding increased training and overhead costs. The utilization of > 1 EMR system magnifies the likelihood of missing vital clinical information and incomplete allergy/medication lists [10]. The protected blockchain items resolve the need to allocate millions of dollars to integrate medical records.

The advent of NFTs and supporting blockchain technology has ushered in an era of true digital democracy, which bodes well for visual fields such as dermatology. For health systems, these developments proffer high data compression

plus enhanced interdepartmental communication. Patients may benefit from heightened data privacy and ownership protocols. From demonstrated efficiency to favorable ethics, attention to Web3’s everchanging landscape may soon be principal to ethical and successful patient management in dermatology.

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