

# Blockchain for Medical Information of Personal Health Record System

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## **Abstract**

*Blockchain technology can be used throughout health and medical field. In particular, we need to pay attention to the fact which medical consumers, that is, individuals who were recognized as a victim of information asymmetry due to the medical information monopoly of hospitals can regain their sovereignty through blockchain technology. In this paper, we suggested a framework that can complete Personal Health Record (PHR) system, using blockchain technology. Current medical paradigm is shifting from treatment to management. In the management, it is important to know not only current health condition but also existing disease and its treatment process. Storage method of medical information is changing to PHR, an integrated record of EMR information additional medical information of patients, beyond the environment where medical information is recorded and stored with EMR system. The emergence of PHR according to such change in the medical field makes it easy to understand the health condition of patients. Therefore, it is suitable for providing personalized medical services to patients.*

**Keywords:** *PHR, Blockchain, Medical, Modeling*

## **1. Introduction**

With constant advance in IT technology, there have been various healthcare devices and services. A number of companies have provided the new healthcare value to doctors and patients using state-of-art technology such as sensor, smartphone, wireless communication, etc. [1]. In this trend, there have been growing efforts to take care of oneself and prevent disease by using smart IT devices, including smartphone, health device, and others, not only for patients but for the healthy people. In other words, interest in and usage of Personal Health Record (PHR) are growing more and more [2][3]. It is presenting new health value to those working in medical sector through innovative companies that develop these technologies. In this trend, not only patients but also healthy people try to manage their own health and prevent diseases by using smart IT devices such as smart phones, health measurement devices, etc. [4][5].

PHR can be recognized as decisive tool for making partnerships between healthcare providers and consumers. It is also expected to reduce or remove duplicate treatment or medical procedures and save the cost and time by using PHR system. Since patients can better understand their health information through this, they can play a more active role in preventive healthcare and disease control, increasing the rights of patients.

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Healthcare paradigm is changing from treatment to management these days. In such management, it is important to record ordinary and periodic information on health condition as well as underlying diseases and information on treatment process. The form of medical information is changing from the environment where medical information is recorded and saved by EMR system to environment where it is saved by PHR, personal health information of patients. This PHR is very useful to understand the health condition of patients, making it suitable to provide personalized medical service to patients. However, it is difficult to complete with PHR since EMR system is created differently for each medical institutions and medical information is integrated accordingly. Cloud can be a suitable alternative since it is easy to build and process integrated PHR while maintaining the system under various EMR systems. In addition, it can solve security and stability issues in the sensitive part of medical information through blockchain. If PHR is built in the Cloud using blockchain, medical information can be used widely while maintaining current medical system. In addition, it applies distributed data process algorithm using blockchain on high costs resulted from the management of individual's data under Cloud environment. This method allows minimizing the costs for individual. The medical information system built in this way will affect positive impact on medical community and help to provide appropriate medical services to patients. Therefore, we present a framework that can complete PHR system by using blockchain technology in this paper.

## 2. Related works

Representative use of blockchain in the field of health is electronic medical records. This field is divided into electronic records-based EMR, interchange-based HER and personal health record based PHR [2][3]. The main research in related fields so far were about the management of personal medical or health related data for generating and storing electronic documents. In fact, the researches on cases of blockchain EMR use were focusing on decentralization, immutability, data sources, reliability, rigidity, contract, security and privacy of blockchain. The focus here is on research on the use of blockchain for storing and managing electronic medical records (EMR) of patients and methods to facilitate data sharing centered on patients in various medical services. In particular, researchers on sharing, processing and using of technology and data that build medical platform, allowing patients control their own methods [6][7][8].

Applications using blockchain technology for managing healthcare data are introducing blockchain to apply perfect security technology in designing medical systems [9][10][11][12]. In this paper, we present architecture for gateway application of healthcare data for easy and safe control and sharing. In other words, we present to use blockchain technology using multi-step authentication to safely protect and share the medical data between different objects that can use the data of patients. In addition, we present research scenarios related to biometrics and biomedicine for the security of medical data.

## 3. PHR and standards

The development of hospital information system, the spread of computerized medical records and simplification of treatment and its support process increase the efficiency in terms of economy and time. Convergence with information and communication technology for outpatient treatment as well as treatment in the hospital has been continuously promoted with the development of hospital information technology. And sharing of information using PHR drawn from individuals allows self-health care of various health institutions and individuals

[2]. Patients first should objectively observe their health condition in doing self-management for health promotion and then clinicians should provide guidelines. Therefore, services that enable individuals to intuitively check their overall health condition including their behavior, diet and work out-related information is required beyond the primary information provided by medical service providers through visualization of PHR. Furthermore, additional installation of Decision Support System (DSS) that provides guidelines for decision making of personal health management within the service providing visualized PHR information is required. PHR will have a positive effect in understanding and legibility when information is expressed by distinguishing characteristics of users and applying personalized visualization technique. However, the design of services that provides personalized PHR information to users has not yet been diversified. In addition, PHR can be summarized as a service that helps consumers to open their medical information anytime, anywhere and directly enter and manage their health information to support lifelong health care. Currently, information system in the health care field is building and operating various systems to meet the increasing demands for health and medical and the budget for informatization is increasing accordingly. However, the current systems are not linked even though they are interrelated between various systems, causing duplicated or manual processing. In addition, only internal information of each institution is mutually connected and only part is connected or all of it is disconnected in sharing information, showing that consumer-centered PHR service such as management of personal history is not sufficient. And standardization or real-time network for information linking with each institution is not prepared yet, causing problems for insufficient real-time provision of various data such as data on current state.

Standards related to PHR can be divided into three areas which are the exchange of PHD (Personal Health Device) information, the exchange of medical information devices and the exchange of information on Internet of Things (IoT) device. First, Institute of Electrical and Electronics Engineers (IEEE) 11073 was enacted in the field of personal health devices. It is distributed as an ISO international standard according to International Organization for Standardization (ISO) and standard harmonization between IEEEs. ISO/IEEE 11073 PHD Group is continuously enacting standards for each personal health device based on standard protocol (ISO/IEEE 11073-20601) to measure and transfer personal biometrics. The exchange of PHR based medical information is necessary to deliver personal health information such as medical records and checkup results saved in medical institutions, and it is classified as follows.

This includes standards for terms, code system, protocol and medical documents in the field of health and medical information. Standards such as SNOMED-CT and UMLS for terms and code systems, LOINC for checkup code, ICD for diagnosis code, RxNorm for medicine code are being used. In case of protocols, there are V2 and V3, a message standard for exchanging medical information, DICOM for transferring medical video image, CCD of HL7 as standard for medical documents and Consolidated CDA. Standardization is in progress related to healthcare including PHR in the field of IoT. OIC has started to develop standards about healthcare applications and services in IoT environment by making Healthcare Task Group and showed showcase that works by linking with IoT standard platform and existing healthcare standards in oneM2M in 2018. As wearable devices such as activity tracker, heart rate measurement and various IoT devices such as sleep monitoring device and smart home devices are developed recently, it is expected that there would be active discussion and enactment for PHR related healthcare standards in the field of IoT in the future.

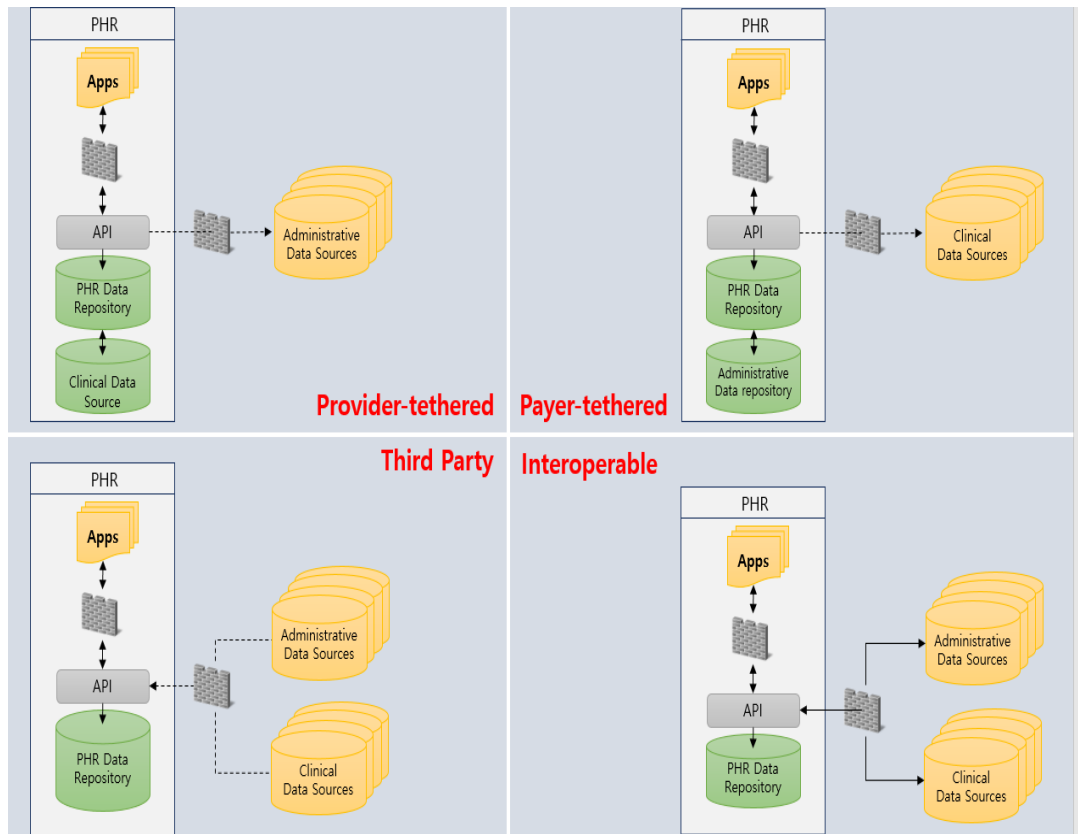


Figure 1. Elements of blockchain

#### 4. Blockchain-based PHR system framework using cloud

Medical industries can manage information such as medical records, accident history, constitution, diseases and checkup history of individuals to enable more accurate medical care and provide better medical services accordingly. In addition, unnecessary duplicated checkup and the costs that come with it can be reduced through this kind of information management. This reduces the economic burden of patients and increases trust in medical treatment. As such, blockchain technology is expected to bring innovative changes in various fields including healthcare, distribution, insurance and medical care.

Method to build blockchain based PHR system is as follows. Basically, security is the most important in PHR. So, functions about this should be implemented. In this paper, it is operated in closed manner so that only approved users based on Cloud that is good to be used by users (medical institutions, patients, etc.) can use, and private key is provided to each user to approve access. This system allows users to create API (Application Program Interface) to process and use data in desired form and gives flexibility to expand use environment when the data is getting big. Cloud is consisted of several layers, which are ‘Layer 1’ where basic information of patients is saved, ‘Layer 2’ where medical information within individual patient information is saved in the form of blockchain and ‘Layer 3’ where information is saved as database that applies HL7 and KOSTOM standardized for each patient. There is a public key that can identify patients in the Layer 1, acting as a role of address that can find the location of patients within Cloud.

Layer 2 is consisted of several nodes and each node is designated by individual users such as medical institutions and pharmacy. When each user updates the block (updating information of patients), other nodes also can be connected to chain by copying the same blocks. As such, it is consisted of multiple nodes and it makes difficult to change information when an external attack occurs. And this makes high integrity of information. Layer 3 builds database through standardization by applying HL7 and KOSTOM, making it easy to be used by users when they want to check medical information PHR of patients or use in their research.

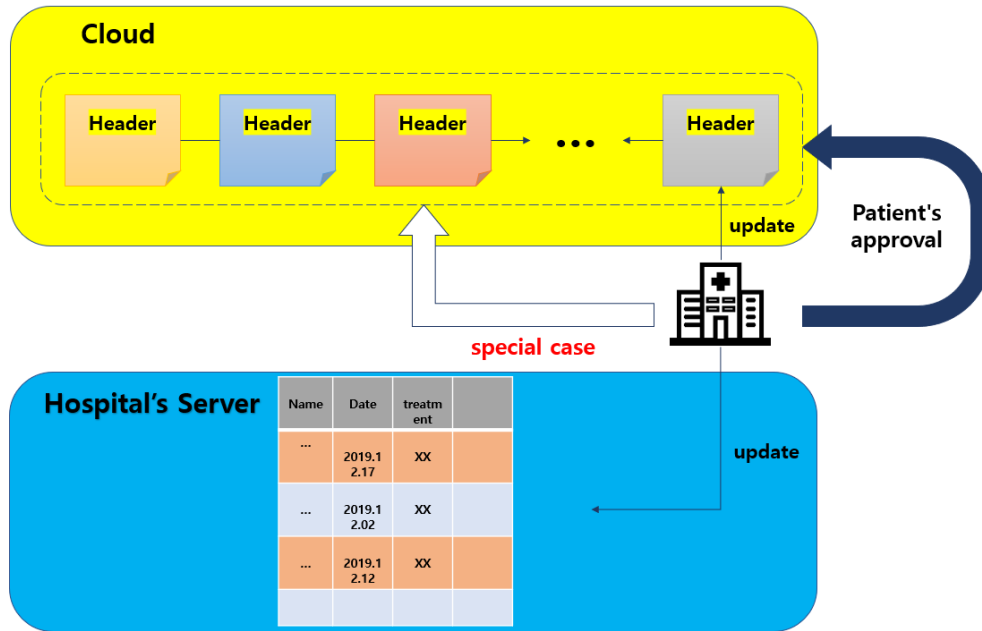


Figure 2. Cloud based PHR

When users who are authorized to update medical information of patients update the block (patient information), they save the information in Cloud and the server existing users use at the same time. In addition, users can update patient information in the Cloud. But encrypted address is recorded in the information to be connected in the same blockchain of header (information of block), making it automatically connected and creating structure that prevent from opening PHR of patients. There may be situation in which PHR of patients should be opened. At this time, PHR can be opened under the consent of patients. Sometimes, it is necessary to use medical information of patients in Cloud DB for the purpose of research. For this case, users can use API in the Cloud to create new DB through the anonymizing process of DB. And researcher registered as a user can access DB to use it for the purpose of research and leave the information for used history in DB.

## 5. Conclusion

Blockchain technology can be used throughout health and medical field. In particular, we need to pay attention to the fact which medical consumers, that is, individuals who were recognized as a victim of information asymmetry due to the medical information monopoly of hospitals can regain their sovereignty through blockchain technology.

Current medical paradigm is shifting from treatment to management. In the management, it is important to know not only current health condition but also existing disease and its treatment process. In particular, storage method of medical information is changing to PHR, an integrated record of EMR information additional medical information of patients, beyond the environment where medical information is recorded and stored with EMR system. The emergence of PHR according to such change in the medical field makes it easy to understand the health condition of patients. Therefore, it is suitable for providing personalized medical services to patients.

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