

OHS: A System to Facilitate Global Exchange of Healthcare Data

Saurabh Badhwar, Garima Anand, Bijendra Tyagi

Northern India Engineering College, G.G.S.I.P.U, contact@saurabhbhadrwah.xyz

Abstract Objective: Different public and private healthcare organizations over the world are using computer technology to store and maintain the healthcare data of the patients which is used in further research or to provide transparency in medical procedures to the patients. The problem with this approach is that all the healthcare data is fragmented and no patient can carry the data when they migrate from one healthcare provider to another. The purpose of OHS is to build a system which can store the data centrally, hence, providing the ease of transitioning from one healthcare provider to another and to facilitate the transparency in the healthcare sector, globally. **Method:** Building a web based service backed by a relational database to store the patient data is used to promote the implementation of the system. The common set of APIs provided by the OHS can be integrated into the EMR systems built by various firms over the world to efficiently report the patient healthcare data to the global OHS database. The implementation of a robust permission system, similar to the OAuth protocol will help the patient in maintaining the data privacy of his associated healthcare data. The projects looking to research into a specific area can tap into the anonymized healthcare data of the patients globally to analyze and understand the trends and patterns which might be arising so as to better implement new policies related to healthcare or to improve the understanding of the drug action pathways.

Conclusion: Open Health System(OHS) can provide a framework to facilitate the global interexchange of healthcare data, resulting into better understanding of the disease patterns and formulation of better policies which can be regionally targeted so as to improve the outcomes. The data can also be used to better understand the actions and performance of the prescribed drugs which can be used to formulate new salts with better drug site targeting and reduction of Adverse Drug Reactions(ADRs).

Key words Healthcare, Data Exchange, Open Health

Introduction

With the advancement in technology and global push for an increase in transparency of collected data all over the world, the organizations are building systems which facilitate the storage and management of healthcare data. These systems are being used to provide the beneficiaries with easy access to their healthcare data as well as to report the anonymized data to the government organizations.

Governmental projects like OpenFDA have been implemented to provide the healthcare data related to drugs, medical devices, etc. available in public.^[5] The EMR systems being developed by various organizations are being used in the Healthcare world to manage the patient records. The problem with these systems is that they don't facilitate the exchange of data on a larger scale. The ability to exchange the data is restricted to a set of small organizations or a specific region. This problem arises due to the incompatibility in the structuring of the reported information which gets influenced by the various identification standards set by the governmental organizations over the world. Also, the policies set by the different countries relating to the collection of healthcare data related to patients also influence the interexchange of information between the systems. Another concern associated with the interexchange of the information between the systems relates to the patient's data privacy which might get undermined due to this exchange of information restricts these systems.

The idea behind Open Health System (OHS) is to build a service and a framework that can be used to facilitate this management and exchange of healthcare data on a global scale while providing the necessary abstractions over the region specific identification methodologies. The specific advantages of this type of system are related to the efficient management of the patient healthcare data which will also facilitate the access to this healthcare information by various institutions over the world which may include Hospitals, physicians, universities and organizations such as CDC, Red Cross, USAID, etc. The access to this information can be utilized in a number of ways such as to identify the disease patterns, understanding the effects and consumptions of a specific drug. The collection and understanding of this information can be made to use in formulation of policies

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related to healthcare or to control the distribution of the drugs. Also, this identification of drugs and their effects on the patients can be used by the researchers to formulate and work upon better salts which can have high specificity.

The privacy concerns associated with OHS are kept to minimal by implementation of a permission system which is similar to the OAuth project. In OHS, all the healthcare information associated with a patient is completely owned by the patient himself. The exchange of information happens solely on the consent of the patient. The idea is further extended by providing the patients the capability to select the specific information they want to share. Whenever a research organization wants to carry out a research on a selected set of patients who have the required medical history, they can send a notification those set of patients to share their data with the agency. This type of permission system although hard is essential to maintain and enforce the privacy of patient's healthcare data. Also, to provide an easy way to share this healthcare information, the patients can enroll with the anonymous information sharing program built into the core of the system. This program will automatically remove any personally identifiable information in the patients' health record before sharing it with the concerned agency.

With OHS, one other factor is taken into consideration – the system should not interfere with the existing systems or should not limit the feature set of customized solutions. This serves the purpose of providing freedom to the users of the system to rollout their own customizations which best fits their use case. OHS provides a set of APIs which can be tapped in by the 3rd party application developers to rollout their own customized solutions which share their data in a conformant format with the OHS database. The availability of this API makes OHS a good platform to work upon while maintaining the ability to best use of resources available at the usage site.

With proper and conformant reporting of data, OHS can turn out to be a central tool in providing transparency in the healthcare sector, where the patients will be able to get access to their medical history, diagnosis and prescribed cure in an easy manner. This approach will make the patients feel more involved with their healthcare provider and will provide them a way to make a decision regarding their cure.

Methods

The first step in the development approach is to define the database schema which will hold on to the database. The database schema is defined on a preliminary basis and is subject to change as the feature set of the OHS progresses.

The following key points have been identified for the successful implementation of the OHS database:

- All the working processes and schema of the system database should be documented.
- The database should identify every patient uniquely through an identification number (OHSID) which is generalized in nature and doesn't depend upon any region specific identification marker.
- The relational tables being used in the system to authenticate the users should identify every single user through OHSID.
- References should be provided for the treatment which is yet under medical trial so as to provide complete information regarding the patients' treatment in case the user wants to switch the healthcare provider
- English should be the primary working language for the database.

System Architecture

OHS is divided into 3 modules so as to promote ease of extensibility and to increase decoupling of components. This decoupling and modular architecture for OHS makes it suitable for extensibility and addition of new features. The 3 layers of the OHS (Fig. 1) consist of:

- **OHS Core:** OHS Core is responsible for managing the low level details of the system which includes interaction with the database, providing services to the API, management of the data caches, etc.
- **OHS API Layer:** The API layer provides a middleware through which the 3rd party application and OHS frontend interacts with the OHS Core. The API abstracts the underlying details of the Core and provides endpoints through which the data can flow to and from the core in a secure manner.
- **OHS Frontend:** The OHS frontend is a runnable web service which provides the user interface to the core application database by tapping into the API layer. OHS frontend acts in similarity to 3rd party applications but with the extended functionality to facilitate the registration of other 3rd party application providers, through which the users can access the required API keys to build their applications.

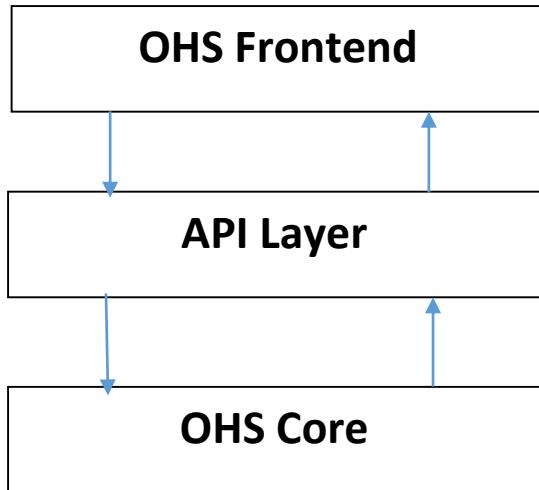


Fig. 1. OHS Application Architecture

OHS Core

OHS Core forms the base of the application and is responsible for all the low level tasks that are required by the application. These tasks include the ability to interact with the database, sanitize application provided data and perform data queries on the database using the data query engine. OHS core provides the last stage of security checks in the application by validating the authentication token embedded in the request and by analyzing the data queries that arise from the API requests being made by the 3rd party applications. Only the queries which are found conformant to the format specified in the core are allowed to execute by the OHS core whereas error messages denoting the query failure with the exact point of failure are generated by the OHS core if the query is non-conformant.

API Layer

API Layer acts as a middleware in the OHS. The API layer abstracts the functionalities available in the OHS Core. This abstraction provides the ease of use of OHS platform by the 3rd party applications without worrying about how the data is sent and stored in the OHS database.

API layer provides a RESTful API which can be used by the 3rd party applications to build their products. The privacy of data while being in transaction through the use of the API is implemented by Asymmetric Key Encryption of data. This encryption provides the security while the data is being transported between the application and the OHS system.

OHS Frontend

OHS Frontend provides the User Interface to the OHS Core. The Frontend communicates with the core in a similar fashion as the 3rd party applications by interfacing with the API layer.

The set of services provided by the API layer is common to both the 3rd party platforms as well as the OHS Frontend with the OHS Frontend having the added functionality of registering new 3rd party platforms which may require API keys to perform API requests.

Discussion

With the advancement in technology and ability to manage large scale data, the healthcare industry is now experiencing Big Data revolution.^[2] This data which is being collected by various healthcare providers and governmental organizations can be used to better frame the policies to find new ways of treatment. Also, this data can be used to build systems which can support the decision making process by the physicians and other healthcare providers hence reducing the chance of reducing the ADRs.^{[3][4]}

This Big Data revolution started with the efforts from the organizations and governments promoting the exchange of information by introducing new policies such as Health Information Exchange (HIE) in the United States and availability of platforms like OpenFDA in United States, MedEffect program in Canada, etc. The researches going on in the healthcare sector focused on identifying disease patterns, understanding the effectiveness of the treatment can utilize this available data to reach higher level of accuracies. These researches can be further improved if the data is available from various regions which lie in different parts of the globe. Currently, the restriction in this approach exists because of lack of implementation of proper EMR systems, concerns regarding the patients' privacy, etc.^[6]

To make an effective system to promote the exchange of the healthcare data on a global scale, we need to identify and fix a few problems. These problems can be fixed only if the awareness about the open data in healthcare is increased among the general public and the governments which are responsible for the formation of the policies. The implementation of OHS system can tackle a few problems and can provide some major advantages, such as, reduction in healthcare costs, increased involvement in decision making process, increased transparency, etc.

Reduction in Healthcare Costs

The global healthcare costs are growing on a yearly basis, the reason being the increase in the aging population which is more susceptible to health risks than the younger sector of the society. This steady increase in the rise of the healthcare costs is proving a big burden on the GDP of the countries globally. This proves to be an issue with countries which are still developing and have a low GDP. The increase in healthcare

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costs can hamper the development of these nations where the money is required to be spent over the infrastructure and other basic services.

Implementation of a global scale health information exchange systems can prove to be of great use in reducing the healthcare costs for these developing nations as well as the developed economies all over the world. The costs of running the infrastructure required to run such a system at regional level is high and redundant when the system can be implemented on a global scale and contributed to through a membership program. Also, the enormous amount of data collected through this system from across the globe can be used by the researchers to understand and propose better treatments which can be more effective and low on costs.

Increased Involvement of Patient in Decision Making Process

The information systems available globally and by a few healthcare providers are semi-transparent and do not reveal all the information required by the patient to get involved in the decision making process for his treatment.

Right now there is a high need for the patients to get involved in the decision making process for their treatment as well as to add the accountability of the healthcare professionals regarding the treatment. The systems providing one place to access all the healthcare data can provide a complete outlook to both the patient as well as the healthcare professionals about the patients' information such as the medical history, diagnosis, current treatment being done, etc. This information can be used by the patient to get a second opinion on the treatment as well as to understand the risks and profits associated with the prescribed treatment. This increased awareness can help the patient in getting more involved with their healthcare provider in the decision making process so as to effectively choose a treatment which is economical and reasonably effective.

Increased Transparency

With a wider set of data related to a patient being available on a single platform, the patient is able to query what all data was collected from his various visits at the healthcare provider. This increases the transparency in the information system being used, hence adding the accountability of the data where a concern can be raised if there is some kind of discrepancy present in the collected data.

which may arise due to the different type of identification schemes that are present over different regions across the globe. The implementation also opens the doors to various kinds of research which can be made possible through the use of collection of large scale data while also promoting the increase in healthcare data transparency across various regions.

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Conclusion

Implementation of OHS reduces the footprint of setting up different types of infrastructure required to run such programs while also reducing the issues of data cross compatibility