

Tackling the Challenges and Preserving Privacy of EHR in India

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Abstract—

EHR in India was the crux of our research paper and overall study was conducted and information about the current system was derived to focus on its shortcomings. Majority of current systems in India fail to fulfill the EHR adoption rate parameters. In India, complete EHR adoption of Stage 7, which defines a system that can positively analyze to improve patient care, currently stands at 0.5%. This portrays the dire need of EHR in India. The primary limitations observed were lack of facilities & infrastructure, patient confidentiality. The model proposed utilizes security as the bedrock to overcome pre-existing drawbacks. The concepts of end to end encryption, hashed database, digital signatures were proposed to overcome the limitations of the current systems EHR in India. The future aim of the proposed model is a small scale implementation to better and save lives using EHR

Keywords—EHR, EMR, Encryption, Authentication, Patient Record, Health Record, Government Hospital

Introduction

Today's world is ever evolving with various technologies, each competing to make the world a safer and healthier place to live. An EHR is one such technology that endeavors to digitize, evolve and unite the healthcare industry as a whole. An EHR or Electronic Health Record is a

collective, over the top umbrella for a patient's medical record. In layman terms, EHR is a virtual version of the patient's medicinal history. An EHR is a real-time report, with its focal point on the patient & makes information immediately and securely available to authorized users[14]. An EHR gives the medical industry the opportunity to connect, co-ordinate and collaborate across the globe, leading to prominent strides in information sharing & gaining knowledge. If implemented properly, it has the potential to be a comprehensively unified system, which has multifaceted advantages.

History of EHR

The history of EHR dates all the way back to the 1960 era. The Rochester based Mayo Clinic in Minnesota is one of the first significant healthcare systems to implement an Electronic Health Record. EHR in the 60s were very costly. Due to this, only official administrations company (government) and health corporations were able to primarily use it. During the 1970 decade, it was exclusively available to large clinics & was used for invoicing and booking appointments. Around the 1980s, healthcare providers have found that in every area of healthcare, from emergency care to rehabilitation, hospital to home, there will always be special cases that need to be solved electronically. Hence development of the EHR accelerated rapidly. During 1990 decennium, this newfound computational knowledge had permeated most clinics and computers were used to a restrained extent for reporting purposes. EHRs particularly found in university in-patient and out-patient healthcare settings and included information exchange for application processing and image scanning for documentation. In the coming of the new age in 2004, President of the USA, George Bush founded the Office of the National Coordinator of Health Information Technology and demarcated plans to fortify the claim of future Americans have electronic medical records before the end of the next decade[15]. Even though we are being introduced to paperless EHRs & EMR software, few standalone businesses continue to use an amalgamation of paperback and computerized entries.[16] Recent improvements in the electronic medical records industry aim to further specialize EHR systems to further modernize procedures, increase productiveness and improve physician-patient interaction. As such, the EHR keep on making active efforts to create a lasting impression on the healthcare industry for generations in the future

EHR in India

Whilst EHRs are well implemented and functional around the world, the Indian Subcontinent paints a different picture. India is an upcoming giant in the technological sector as well as medical sector due to its immense population strength. Digitizing healthcare is one of the government's key goals to provide equal opportunity for medical treatment at affordable costs. The Government of India is also eager to use domestically generated data to enable affordable drug discovery and health research. India has recognized the superior advantages of the EHR system in terms of revamped patient coordination, surge in patient engagement, refined medical research and reduced healthcare costs. The Indian Government has also made active efforts to implement EHR by implanting various schemes for the general public. They launched the Universal Health Coverage scheme, known as the Ayushman Bharat Yojana in 2018.[13] This national insurance scheme in the health sector has two main schemes -

- (i) The Pradhan Mantri Jan Arogya Yojana (PM-JAY), which arranges to supply a Rs 5,00,000 cover to the lower 40% of the Indian populace for secondary and tertiary care.
- (ii) The inception of around 1,50,000 health and wellness centers across the Indian subcontinent for primary care, with a focus on underdeveloped regions.

As a result, there are government mandates to take enforce the necessary measures to ensure that beneficiary health records are collected on a timely basis, these records are digitized and EHR systems are implemented. In 2019, National Digital Health Blueprint, to create pan-India EHR was proposed. The 'National Health Stack', an ingenious digital structure, has been suggested by the National Institution for Transforming India (NITI Aayog), with the objective of creating a virtual health record for all inhabitants of India by 2022.[13] Hence, we can observe that multiple notable attempts have been initiated for the medical wellbeing of India in a virtualized format, but no concrete system is in place as of now. In the successive sections, we discuss a proposed system to overcome the challenges faced by the currently present EHR systems in India.

Literature Survey

A. Implementation and impact of electronic health record system in healthcare

Swati Yanamadala, BA, Doug Morrison, MS, Catherine Curtin, MD, Kathryn McDonald, MM, MBA, and Tina Hernandez-Boussard, PhD [1] proposed that EHR systems are implemented in various hospitals to improve the patient treatment standard. Its main aim is to be better at patient care and support. With the help of an operational study hospitals with fully functional EHR, partial EHR and hospitals without any EHR were compared. The comparison was based on patients' mortality rate and the overall patient outcome.[1]

The results of this study showed that fully functional EHR hospitals had the lowest death rate for surgical and medical patients, followed by hospitals with only partial or without EHR systems. When additional patient and hospital factors were accounted, these results, however, were not consistent. When all different factors were considered, it showed that the role of EHR in patient outcome was not the most significant, however it did enhance the patient experience. These findings suggest that the outcome for patients receiving surgical and medical treatment at hospitals without an EHR system are similar to those for patients receiving care treatment at hospitals with a complete EHR system in place. Thus, as of now there is no proven evidence that guarantees improved patient outcome due to EHR.[1] However, maintaining a paper-based record for an individual is not the most efficient for the healthcare system. This is where electronic health records can come to the rescue if they are implemented with pre-defined standards.[2] For an EHR to be useful and efficient for the patient treatment, it must be compact, to the point but must cover all health data of an individual. This can be accomplished if information is exchanged as images, clinical codes and minimal dataset. Each entry in your clinical record describes a life event as individuals experience it. Depending on the concerns the individual is currently struggling with, a document may be irrelevant or relevant. Appropriate security procedures must always be scrupulously followed to maintain data security and privacy. Additionally, patients must all be permitted to access their healthcare information at any time and confirm its integrity. Every 24 months or as appropriate, EHRs should be reviewed and updated to ensure they are correct at all times.[2]

B. Fraud Related to Electronic Health Records

Maintaining an up-to-date and accurate EHR record is crucial. Inaccurate medication records can lead to prescription errors and harmful drug interactions. Due to faults in the electronic health record (EHR) or problems with interoperability between the other systems, significant results might not be reported. Due to poor system interfaces or coding faults, inaccurate information may be recorded, or wrong commands may be issued. It is also important that the EHR system works as intended. When an EHR supplier or healthcare provider manipulates the system to receive incentive payments that they are not eligible for, they are committing fraud. Providers who knowingly misrepresent EHR incentive payments should be held liable. Providers have resolved complaints that they intentionally misrepresented how the system or service was actually used. EHR providers may be held liable for misleading claims of

government incentive payments, even if they themselves have not received such payments from the government[17].

EHR users can help prevent or mitigate the risk of billing and document errors when government and private payers step up to EHRs to review and enforce improper accounts, one should consider taking many steps to defend themselves properly. There should be policies and procedures related to EHR functions, such as whether copy and paste is allowed and how often electronic documents are reviewed. These activities increase productivity and are not prohibited but should be used judiciously. Ensure that the EHR system is not designed to promote or encourage fraud.[17]

C. Current status of EHR systems in India

Soham Sinha¹, Srishti Majumdar and Arpita Mukherjee [4] proposed that India being a developing country and second largest population on earth has a critical need for electronic health records. The government of India is now focused on digitalizing the healthcare system to better the patient data management and detect the illnesses better. However, the current scenario is far away from ideal. Only limited hospitals (private) are seen to have EHR systems even in cities of India. [4]

From the survey conducted it was found that, EMR systems were used in only 8 of the 13 hospitals to maintain patient information. The data was utilized for evaluation, quality inspection, and hospital improvement planning. For billing, the Health Information System of 5 additional EMR systems was utilised. Village hospitals are still seen keeping paper copies to monitor patient health. Nearly all of the hospitals that participated in the survey had intentions to either adopt EMR, expand current EMR, or switch from EMR to Electronic health records. These targets and their realization, however, are still in the early phase because of the hospitals' constrained IT expenditures and other factors. [4]

Existing systems

Here are few proposed electronic record keeping systems that are relevant to India.

D. EHR framework for Indian Healthcare System

This is a cloud based EHR system model where in the first level of this suggested EHR model's four tiers of operation are the gathering of patient data from various healthcare units within a hospital. The EHR Network is created by combining the data gathered from each department. Algorithms are used to process the entire collection of data, which is subsequently saved in a cloud database. In order to store and distribute patient information over the EHR network, this architecture essentially links all users of health information systems in a single location. It makes use of a cloud-based infrastructure that enables patient data to be entered by all healthcare system segments. These cloud resources are maintained in a cloud database known as the EHR universal health service provider and shared with various levels of the healthcare industry. Using an EHR Web application, healthcare practitioners may safely access the patient's data. However, information must be gathered from a variety of healthcare facilities, including administration, laboratories, pharmacies, nursing, and radiology, in order to get a patient's comprehensive medical history. [5]

This strategy makes use of the patient's Aadhar ID or any other identification they may have with them when they check into the hospital. Instead of creating a new ID that would be unique at each healthcare institution, this patient's unique ID is added to the system, enabling access to the patient's data from other healthcare facilities. This concept combines a MongoDB Atlas cloud cluster and a number of collections to create a cluster in the cloud to store health data. Using an EHR Web application, the data processed from the cluster's collections is then presented to the end user, a healthcare professional. This approach suggests a universal platform that may be accessed at any time and from anywhere in the world.[5].

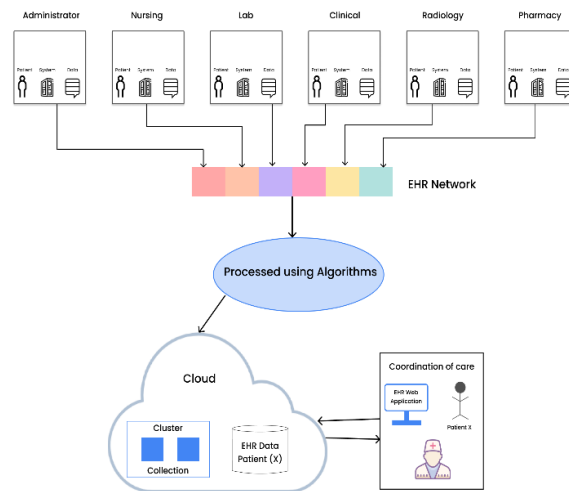


Fig. (1) Proposed cloud based EHR model[5]

E. Electronic medical records (EMR) Android application in outpatient setting

In essence, this technology is utilized to coordinate patient doctor appointments. Here, the user may use an Android application tailored to the healthcare facility to request an appointment and manage all of their upcoming appointments. The doctor can use this application to check all of the patient's appointments as well as approve or reject their own. The SMS appointment reminder delivered to the patient 30 minutes before the appointment is another useful feature of this Android EMR system. The healthcare facility administrator is in charge of the doctor and patient sides.

There is no patient information system in hospitals that specialize in outpatient services in Fiji. There is a significant reliance on manual filing for keeping track of patient data. This is not the most effective approach when individuals are waiting to be served in an outpatient line. Thus, a system with the intention of addressing this issue was presented. [6]

This Android application is not really a web-based system; thus, they rely on OpenEMR, which provides an example of how the suggested databases are accessed by Android applications using the key application.[6]

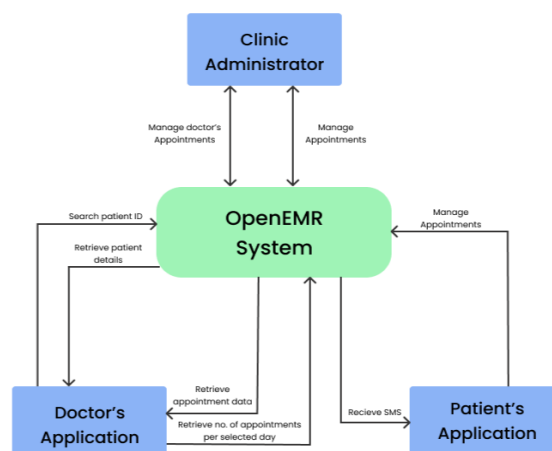


Fig.(2) Context diagram for the proposed EMR system.[6]

The prototype of this application was built using a 64-bit Linux operating system with OpenEMR 4.1.2 installed and set up as a web server. Two Android apps that access the database from OpenEMR, a doctor app and a patient app, were developed using the Eclipse Android development toolkit. Setting up an Android application with an existing database on OpenEMR is difficult to implement, but messaging services, calls, and data collection operations can be implemented using various emulators with target application programming interface (API) capabilities. After updating the feature permissions in the manifest files of both applications, the feature was available.[6]

A PHP code file specified on the web server is used by the Android app to access data from the web server hosting the OpenEMR database. The OpenEMR database is accessible via the PHP file's MySQL queries, which connect to get the data needed, which is supplied as a JSON object (a format that Android applications can read). The Java class HashMap ArrayLists is used to gather the data supplied by the JSON object, which is later displayed to the Android user. The Android app calls the PHP file location to run a line that establishes a connection to the OpenEMR database. After the query execution, the connection is terminated.[6]

Limitations

Although there is a growing corpus of data on the benefits of various EHR capabilities, possible disadvantages of this technology has been pointed out.

1. These include monetary challenges, workflow modifications, temporary productivity drops brought on by the adoption of EHRs, privacy and security concerns, and a host of unanticipated effects.[8]
2. Hospitals and doctors are prevented from adopting and implementing an EHR due to financial barriers such adoption and implementation costs, ongoing maintenance costs, declining profitability associated to momentary loss of productivity, and revenue declines. [8]
3. Another disadvantage of an EHR is the disturbance of provider and medical staff workflows, which results in brief productivity reductions. There will be a decline in performance while end users adjust to the new system, which could lead to monetary losses. [8]
4. Patients are getting more apprehensive about the likelihood of patient privacy breaches as a result of the increased amount of health information being sent virtually, which is yet another potential drawback of EHRs.
5. Incorrect information may enter a patient's medical record when doctors, nurses, or other professionals copy and paste information without updating it. Inappropriate copy-pasting may also make it easier to make duplicate or fraudulent claims or exaggerate legitimate ones. Users can choose information from one source and replicate it in another area by copying and pasting.
6. Overdocumentation is the practice of adding fictitious or pointless documentation to give the impression that higher level services are being supported. When employing system-built templates, some EHR systems automatically fill in the fields. These characteristics may result in information that suggests the practitioner provided more extensive services than were actually provided.
7. Hospitals and "qualified professionals" who work in the healthcare industry buy EHR systems from EHR vendors. In order to defray the cost, EHR providers submit claims to HHS for incentive payments. It has been discovered that EHR businesses produced specific versions of their software just for accreditation testing. [18].
8. Untrue Billings As a result of EHRs, EHRs may lead to erroneous and exaggerated invoicing in addition to accountability for submitting fraudulent claims for EHR additional

compensation. Medical procedure intricacy or frequency can be upcoded due to EHR system programming decisions. Unbundling, the practise of charging separately for services that ought to have been invoiced as a package [18].

Proposed System

It is essential to protect healthcare providers and other organisations that process, use, or transmit patient information from criminals, as protected health information is one of the world's most valuable and sensitive information to criminals. For patient data to be secure, it is essential that it be accessible only to authorised personnel and used only for authorised purposes. To solve this problem, the proposed framework tries to bind patient data in an encrypted way so that it can be accessed through special authentication or decryption keys. For clarity, this process uses cryptographic keys to encrypt data so that only authorised users can read it.

End-to-end encryption uses the same process. Examples of sensitive matters that require data protection include business documents, financial data, legal proceedings, illness, and personal conversations. As a result, failing to protect personal data can be detrimental to businesses and their customers. End-to-end encryption helps protect your data from cyberattacks.

A centralised policy management system for privileged users that puts you in control of exactly who has access to what information Combined with a key management system compatible with the Centralized Key Interaction Protocol (KMIP), organisations can encrypt and protect data at any level.

End-to-End encryption starts off evolved with encryption, a manner of defensive facts via way of means of changing it into an unreadable shape known as ciphertext. Only an individual with a non-public key can examine the message. The sender or author of the information can use E2EE to shield it. Public-key cryptography makes use of separate keys to cipher and decode information. The overall public key may be used to send and receive messages. A message can be best decrypted with the use of the corresponding non-public key (additionally cited as the decryption key). For instance, the Transport Layer Security (TLS) encryption protocol prevents 0.33 events from intercepting messages in transit. In password control and over-the-air radio (TETRA), customers are each encryptors and decryptors. Then get the encrypted information for decryption. Symmetric encryption can be a form of encryption that makes use of a mystery symmetric key to encrypt plain text and decrypt ciphertext.

Benefits Of Data Encryption :

As more businesses flow to hybrid and multicloud environments, issues regarding public cloud protection and information safety in these complicated environments are growing. Protect information on-premises and inside the cloud with enterprise-wide information encryption and encryption key control. A cloud service provider (CSP) can also be accountable for the safety of the cloud; however, clients are dependable for protection within the cloud, specifically for all information. An organization's touchy information ought to be blanketed, even as it permits legal customers to attempt to do their jobs. This safety shouldn't best encrypt information, however additionally offer sturdy cryptographic key control, get entry to manage, and audit logging capabilities. A strong information encryption and key control answer must offer the following capabilities:

- Centralized control console for encoding and encryption key coverage and configuration
- File, database, and application-degree encryption for on-premises and cloud information
- Role- and group-primarily based totally get entry to manage and audit logging to guide compliance
- Automated key lifecycle procedures for on-premises and cloud encryption keys

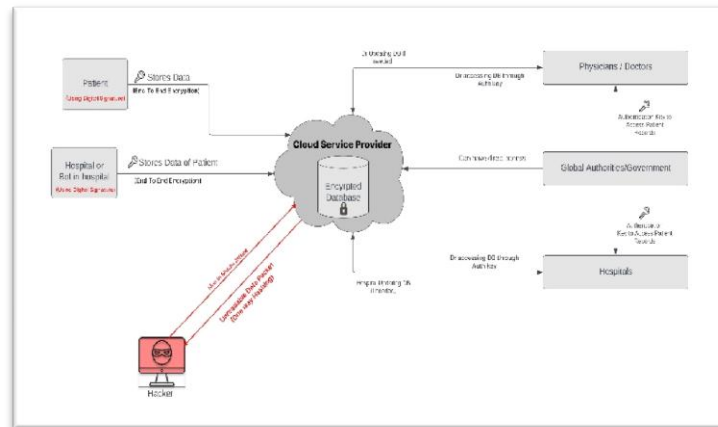


Fig (3) Proposed model block diagram

The digital signature for patient verification is implemented in the version shown in the above figure. A digital signature can be a virtual signature. A mathematical technique is employed to affirm the authenticity of a report. It's nearly identical to a handwritten signature or stamp, however, with greater protection. The matter of forgery and counterfeiting in virtual communications may be solved with the use of virtual signatures. A virtual signature is often used to show the beginning of a digital report transaction or virtual message. They will be used to affirm knowledgeable consent. Digital signatures are legal inside the United States and lots of other countries. Public key cryptography additionally cited as uneven cryptography is utilized in virtual signatures. One among the keys is a non-public one and the opposite is a couple of public keys. Digital signatures paintings with public key cryptography. The signer's public key is the best way to get the non-public key used inside the virtual signature. If the recipient cannot open the report using the signer's public key, this means there is trouble with the report or signature. That is often how virtual signatures are authenticated.

Conclusion

The enhancements made to the existing EHR system will undoubtedly increase the competence of the healthcare system while overcoming major security issues. Authorization factor will help not only to boost the system for well-built healthcare as well as will also provide higher level of security and a wider range of benefits of EHRs. Indian government should boost and encourage building up EHR infrastructure for maintaining medical record of every citizen which will help every medical practitioner to efficiently understand the past history of the patient. National policies are required to ensure the stability and regularity to overcome the challenges. Advocation for more such creative approaches should be highly encouraged for building up cloud-based systems for EHR.

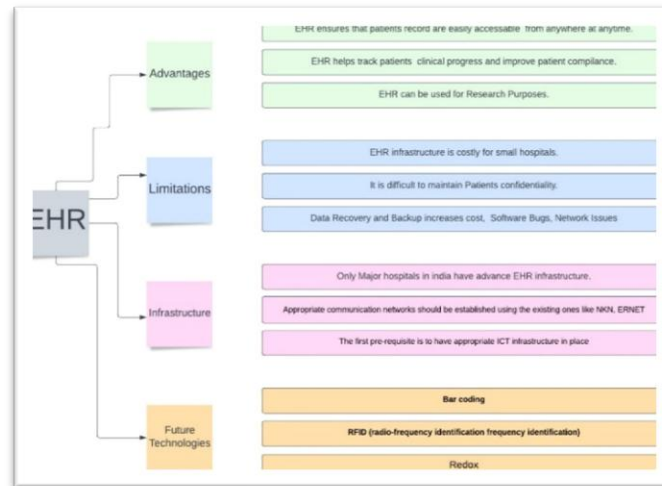


Fig (4) Mind map

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