

Heuristic Walkthrough Usability Evaluation of Electronic Health Record with a Proposed Security Architecture

Prajakta Pawar, Sushopti Gawade

Abstract: There currently appears to be concerted efforts at national (HSE) Regional (EU) and international (WHO) level to promote the replacement of paper-based record systems with electronic health record systems (EHR) for improved efficiency and effectiveness of management of patients' records. However, one of the areas of slow evolution is our healthcare system. With the recent developments in information and communication technology, healthcare is constantly undergoing changes, with new medical technologies, business models and research findings. It has evolved as a new data-centric, more precise, productive, accurate and timely system which can make the difference of life and death in acute situations known as Electronic Health Records (EHRs). This paper studies existing architecture of EHR and draws security flaws in it. The paper has tried to overcome the flaws and has proposed an architecture of EHR.

Index Terms- EHR, heuristic walkthrough, EIP, usability evaluation

I. INTRODUCTION

This paper mainly integrates the information technology (usability engineering) with the healthcare domain. Usability improves human tool interaction. We have focused on the usability aspects in the electronic health records i.e. by making use of technology; we can improve usability of electronic health records. We have studied the existing architecture of EHR and have analyzed the issues in it. Then we have proposed a new architecture which tries to overcome the security flaws and other issues found in the analysis.

A. The Electronic Health Record

"The Electronic Health Record (EHR) is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information

are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports. The EHR automates and streamlines the clinician's workflow.

It performs immediate checks to ensure proper diagnostic questions are asked and ensures providers and patients follow up on treatments. [5][3]

B. Components of EHR

Every EHR consists of diverse components from pharmacy to clinical documentation. Consider component Pharmacy/Medication Safety component which consists of various subcomponents such as Medication Order Entry, Medical Dispensing, Med Charting, Dosing Mgmt, Drug Interactions and Drug Database. Each subcomponent has a set of functions to deploy. Similarly EHR is a composition of number of components and subcomponents out of which each of them has number of functions which contribute to the overall functioning of EHR. [4]. The other components being Physician Clinical Prediction, Health Information Management, Clinical Decision Support, Enterprise Patient access, Departmental Support Services, Supply Chain, and Clinical Documentation.

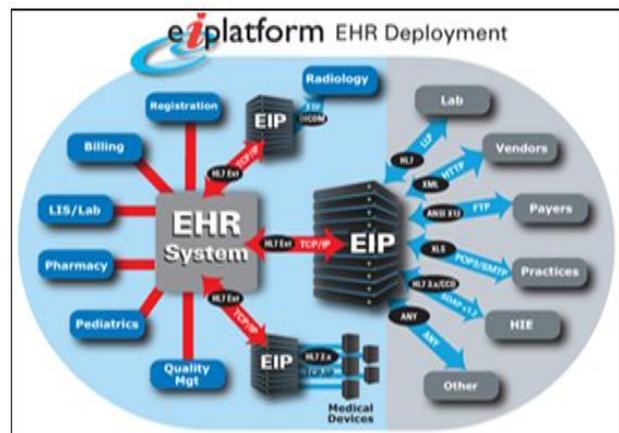


Fig 1: EHR Deployment

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C. Working of EHR

As soon as your doctor makes a referral, all aspects of patient care are tracked. Patient information is made centralized. Prompts are given to the doctor to check for specific medical tests based on complaints and medical findings. Patient treatments are tracked (including if prescriptions were filled and that patients remembered to attend any follow up appointments). The EMR is programmed to automatically to generate a report to the referring physician or a patient summary in the hospital chart. As shown in the fig.4 the user collects the clinical data and stores in the system. The MPI (Message Passing Interface) in the system is deployed to connect to the provider system which is EHR. The patient's data backup is send to the provider EHR through MPI. EHR can communicate to the end user over the network for any tasks to be performed like querying patient's data or drawing the patient's medical report. All the EHRs are connected in the

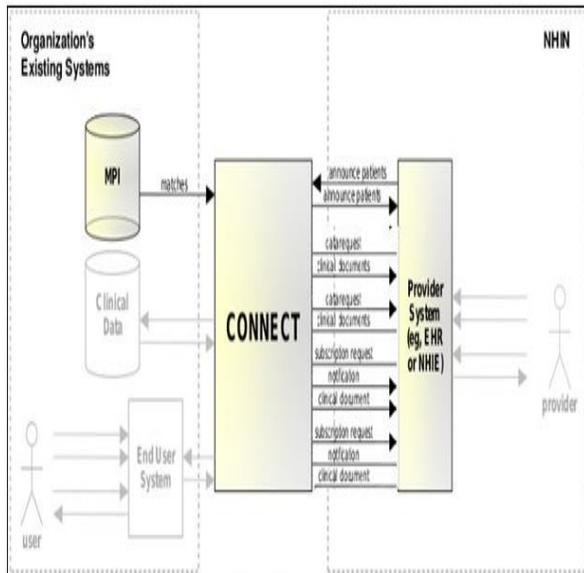


Fig 2: Working of EHR

network which is called the NHIN (National Health Information Network).

D. Reference Model of EHR

Reference model of EHR is shown in the fig.3. The reference model displays various layers such as Reference layers such as physical layer called EHR Media Layer, EHR Transport Layer, EHR Messaging Layer, EHR Host Layer, and EHR Administrator Layer. Security at each layer is shown in the diagram. Auditing and Access Control layer is at the administrator layer. Public key Encryption is provided at the EHR Host Layer, etc. Each layer performs its functions it is meant for and supports the

layer above it.

II. SYSTEM DESIGN

The existing architecture is shown in fig.6. Data from each department is collected into the database inside a database server. This server or number of data servers are attached to the EHR over a network. The EHR is connected to various applications and each application gives User Interface to the user on the other end. The applications include Admin App, Nursing App, Lab App, Clinical App, Radiology App, Pharmacy App, etc. Whenever a physician or nurse wants to access any application which they require to use for any particular task, they can easily access over any terminal. [8]

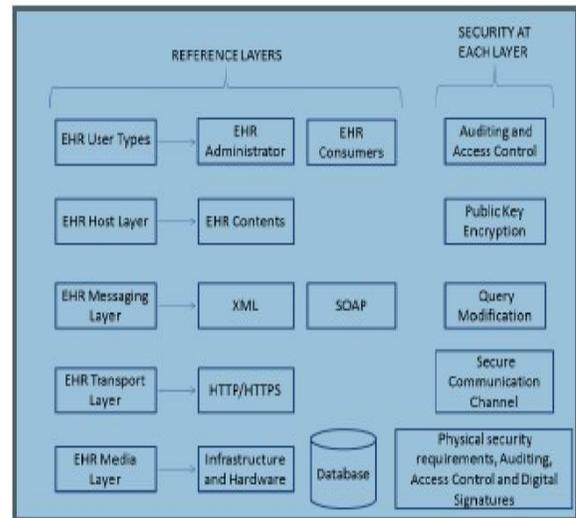


Fig 3: Reference Model of EHR

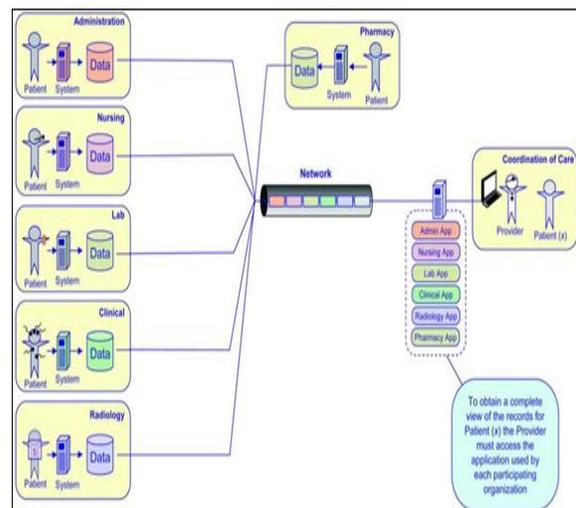


Fig 4: Existing Architecture of HER

III. ISSUES IN EHR

A. Usability Issues

1) Poor Organization and display of information
To perform tasks efficiently and correctly, clinician EHR users need clear, concise, and easily accessible information and well-integrated system functions. The limited screen space and poor interface designs of some systems add to clinician's cognitive workload and increase the risk of error such as double dosing, wrong orders. [7]

2) EHRs do not match user's workflow
Clinicians' complaint that the EHRs do not have compatibility between the work structure imposed by the system and the routines that clinicians typically follow, there is likely to be resistance to the technology. Scrolling through the long list of patients' records is time consuming.

3) Increase in cognitive burden
Clinicians are conducting tasks under significant time pressure and requiring multiple demands for their attention. When time pressures, conflicting demands, and information burden are combines, it leads to cognitive overload. The likelihood of errors increases when EHRs do not adequately support mental models of physicians.

4) Poor design of system functions
Poor documentation capability at the point of care affects the quality of information to support health care decisions as well as other key activities including compliance. Extensive use of defaults, templates, and copying may affect data quality and increase potential for fraud and abuse.
Poor design can be overcome by creating the design interfaces with complete user function requirement.

B. Security and Privacy Issues of EHR [7]

If confidential records end up in the hands of a person not privy to the information, the consequences can be overwhelming. Breach of medical records could lead to identity theft, which can destroy a person's finances, credit and reputation. Victims could seek litigation against the healthcare practice in which the breach occurred. If the breach affected multiple patients, the practice is headed down a long road of legal tribulations.

C. Solutions to Security and Privacy of EHR

Nitro Security and Forewarning with SIEM organization have teamed to deliver the industry's most comprehensive EHR privacy monitoring and security solution. Following are the steps taken to overcome the security and privacy concern of EHR.

- 1) Enhance administrative controls
- 2) Monitor physical and system access

- 3) Identify workstation usage
- 4) Audit and monitor system users
- 5) Employ device and media controls
- 6) Apply data encryption.

IV. USABILITY EVALUATION OF ELECTRONIC HEALTH RECORD

Usability evaluation is a process which can be performed in many ways as already explained earlier. We will use Heuristic walkthrough method. Heuristic walkthrough method is the combination of two methods- Heuristic Evaluation and Cognitive Walkthrough. [1]

a. Cognitive Walkthrough

Cognitive walkthrough is task-specific, whereas heuristic evaluation takes a holistic view to catch problems not caught by this and other usability inspection methods. The method is rooted in the notion that users typically prefer to learn a system by using it to accomplish tasks, rather than, for example, studying a manual.

Experts perform the evaluation on the tool and check how the user uses his/her cognition to complete the provided task. Study of human cognition involved in the cognitive walkthrough allows the evaluators navigate them through the process of evaluation. [1]

b. Heuristic Evaluation

It was developed Jacob Nielsen in early 1990s. The goal is the identification of any usability issues so that they can be addressed as part of an iterative design process. It helps find usability problems in a design small set (3-5) of evaluators examine UI. Also it independently checks for compliance with usability principles ("heuristics"). The process requires that a testers (or "evaluators") examine the interface, and judge its compliance with recognized usability principles (the "heuristics"). The figure fig.8 explains that heuristic evaluation in which experts called evaluators perform the evaluation of the tool under consideration. This method is expert based evaluation method. [1]

V. USABILITY EVALUATION OF CLINICGATE EHR

ClinicGate is the EHR we are using on which we are supposed to perform usability evaluation. Fig.5 shows the user interface of ClinicGate EHR.

Phase 1: Task Oriented Evaluation

- Cognitive Walkthrough Of EHR

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- Step 1: Choose A User : A user has to be chosen from the population who will be considered for the evaluation. User can either be experienced user or an inexperienced like a layman also called as novice user.[1]
- Step2: Define The Goal & Tasks : The tasks that the user has to do is to be planned , analyzed and predefined. The task has to be valid and relevant to the user in the sense that they are required by the user. The difficulty of the tasks also decided the cognition of the user.
- Step3: Perform The Tasks : The tasks after analysis are performed by the user sequentially.
- While performing the tasks the user has to



Fig 5 ClinicGate EHR

respond to the tool for the required task and the system will respond to that action by the user. Then the user gives his reaction and this process goes on till the user is satisfied with the task completion. [1]

- Step4: Ask Questions To Users : After the completion of the task by the user the evaluators consider each task separately and asks certain questions to the user on the individual task. The user gives the responses to each question according to his understanding and the evaluator analyses and records the cognition of the user. All the analysis together contributes to task analysis of the usability of the tool.

Phase2: Free Form Evaluation

- Heuristic Evaluation of EHR
- Step1: Plan Your Evaluation:
 - For carrying out the evaluation it has to be planned prior to conducting it. Planning involves deciding the flow of evaluation. Analysis of how each step is to be carried out is done in this step.
- Step2: Choose Your Evaluators: In this step the evaluators are chosen who will be conducting the entire evaluation process. Mostly choose the

expert evaluators for this process as in this phase of evaluation the heuristics come into the picture. The evaluators should understand and identify each heuristic associated with each particular task or subtask. [1]

- Step3: Review The Heuristics: Nielson's heuristics are used for evaluating each aspect of the tool. Normally 8-10 heuristics are applicable and can be effectively used to evaluate the usability of the EHR further.
- Step4: Conducting the Evaluation: The evaluation involves analysis of each heuristic against each positive and negative aspect associated with the heuristic.

VI. PROPOSED ARCHITECTURE

Various EHRs from home, physician's office, healthcare organizations, healthcare financing, Public Health Organizations and Clinical Research Centers are connected to the Healthcare Information Network over the internet. The idea that differentiates the existing EHR architecture from the proposed architecture is as follows. [6]

- Existing Architecture of EHR faces security and privacy concern as there is an EHR network to which all the organizations are connected over the network.
- If any security breach exploits any vulnerability in the EHR network then it may affect the entire network.
- This security drawback can be overcome by providing a separate EHR application and many such EHRs will be connected to the Health Information network.

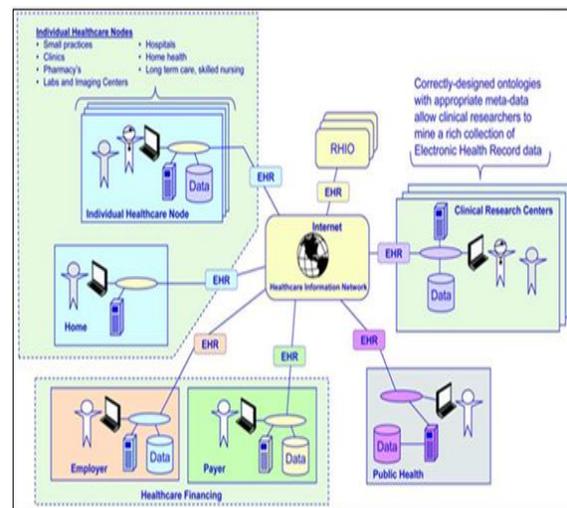


Fig 6: Proposed Architecture of EHR
Advantage is that if EHR faces any security

attack it will only affect that EHR and will be related to only one organization. Loss of assets is lowered in this proposed solution.

- Proposed architecture is provided with the solution to the existing drawback. This proposed solution is shown in the following figure fig.8.

VII. FUTURE VISION OF EHR

The advent of the Nationwide Health Information Network may be the ultimate means of integrating clinical and translational research information over large patient populations. Interoperability standards, tools and architectures that are developed for this network might well be used to enhance interoperability across the AMCs as well. The leading EHR vendors are participating in developing technologies for the nationwide network that will be incorporated into their product base. More efforts are needed to make EHR reach to every healthcare organization.

VIII. CONCLUSION

Security, privacy, confidentiality have been major concerns with currently used EHR systems. Effort have been taken to fairly propose a near about solution to the security flaw in the existing EHR system. A usability evaluation has been performed using the Heuristic Walkthrough usability inspection evaluation method. This method proved to be a very cheap method and easy to perform, being an excellent method to evaluate the presented EHR. In addition to this, the heuristic walkthrough has provided immediate results about the usability of the EHR system by identifying the EHR usability issues. Moreover, this evaluation made possible to the hospital; recognize the level of usability stated on their EHR. The aim is to improve the usability of the EHR, providing better working conditions to the patients and other users, as well as improving their satisfaction.

REFERENCES

1. Usability Evaluation of Electronic Health Record, 2012 Rui Pereira, J'ulio Duarte, Maria Salazary, Manuel Santosz, Jos'e Neves, Ant'onio Abelha and Jos'e Machado
2. HCI Issues in Healthcare IT Ann Fruhling Information Systems & Quantitative. Analysis University of Nebraska, 2012 – Omaha Omaha, NE 68182-0500 afruhling@mail.unomaha.edu
3. A Brief Survey : Usability in Healthcare Saphina Mchome, Shelly Sachdeva, Subhash Bhalla Graduate Department of Computer and Information

Systems, University of Aizu, Aizu-Wakamatsu, Fukushima, Japan.m5131203, d8111107, bhalla@u-aizu.ac.jp

4. Electronic Records Overview – NIHNCRR – National Institutes of Health National Centre for Research Resources, April 2006
5. EHR Usability Toolkit: A Background Report on Usability and Electronic Health Records Prepared for: Agency for Healthcare Research and Quality U.S. Department of Health and Human Services 540 Gaither Road Rockville, MD 20850.
6. The Importance of Usability in Electronic Health Records, Core Solution's whitepaper
7. <http://www.ironmountain.com/Knowledge-Center/Reference-Library/View-by-Document-Type/General-Articles/E/Electronic-Health-Records-Security-and-Privacy-Concerns.aspx>.
8. http://en.wikipedia.org/wiki/Electronic_health_record
9. <http://www.himss.org/library/ehr/>
10. http://www.med-sites.com/clinicgate/Medical_Billing_Software_Clinicg08.asp