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Measuring Use of Electronic Health Record Functionality Using System Audit Information

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Abstract

Meaningful and efficient methods for measuring Electronic Health Record (EHR) adoption and functional usage patterns have recently become important for hospitals, clinics, and health care networks in the United State due to recent government initiatives to increase EHR use. To date, surveys have been the method of choice to measure EHR adoption. This paper describes another method for measuring EHR adoption which capitalizes on audit logs, which are often common components of modern EHRs. An Audit Data Mart is described which identified EHR functionality within 836 Departments, within 22 Hospitals and 170 clinics at Intermountain Healthcare, a large integrated delivery system. The Audit Data Mart successfully identified important and differing EHR functional usage patterns. These patterns were useful in strategic planning, tracking EHR implementations, and will likely be utilized to assist in documentation of "Meaningful Use" of EHR functionality.

Keywords:

Medical Records Systems, Computerized/utilization

Introduction

Early in this decade, adoption of Electronic Health Records (EHRs) was identified as an important factor in improving healthcare in the United States [1]. In spite of this recommendation, recent EHR adoption rates in the United States are low, with only 4% of ambulatory physicians using a 'fully functional' electronic record system in 2008 [2]. With the passage of the American Recovery and Reinvestment Act (ARRA) of 2009, over 19 Billion dollars was targeted for healthcare information technology (HIT) projects to accelerate the adoption of EHRs and other technology. Much of this money will be used for incentives for ambulatory physicians and hospitals that demonstrate "meaningful use" of HIT [3].

At this time, demonstration of "meaningful use" of HIT is still being defined by committees that report to the secretary of Health and Human Services. Early indications are that " meaningful use" will be measured by determining use of certain core functions found within most EHRs. Core functions were identified by the Institute of Medicine and categorized into eight groups including Health Information and Data, Order Entry Management, Results Management, Clinical Decision Support, Population Management, Patient Support, and Administrative Processes [4]. These categories of core functions were used successfully in a recent nation-wide evaluation of EHR adoption [2].

We expect that the adoption rate for certain functions will be required to demonstrate meaningful use of EHRs. For example, it will likely be necessary to document which functions (e.g. Computerized Physician Order Entry (CPOE), Eprescribing, Problem List, etc.) are used by clinicians. In addition, we expect that the level of adoption or extent of utilization of each functionality by each physician will be required. For example, determining if a physicians uses CPOE will not be sufficient, but reporting the extent of this use by providing the percentage of patients that orders entered via CPOE will likely be required.

To date, the method of choice for measuring EHR adoption has been by survey of EHR users. While surveys have their advantages, they also have the disadvantage of being periodic in nature, subjective, and somewhat intrusive. Alternative methods to track adoption of EHR systems were carried out during early implementations of our ambulatory EHR at Intermountain Healthcare. It was found that accessing the EHR transaction logs and data repository provided data that correlated to system usage [5]. Using this new automated source of information, adoption rates could be tracked continuously. For example, the number of physicians entering medication orders per day could be tracked on a daily basis or rolled up by month as shown in Figure 1. These computer tracking methods were shown to have certain strengths. For example, the data were objective and comprehensive, were available on a continual and often immediate basis, extraction of the data was inexpensive, and the data were relatively easy to collect and analyze.

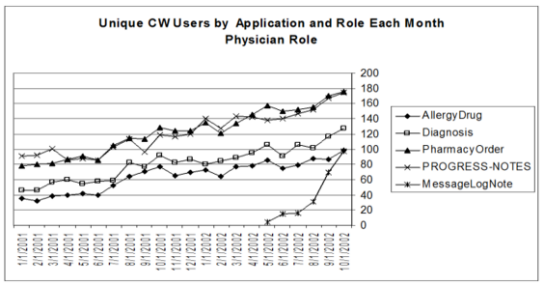

Figure 1- Early example of EHR Adoption Chart showing growth in users by month and by function (Orders, Messaging, etc.). Our early EHR application was known as CW.

Early success with creating computerized, real-time adoption measurement tools from the EHR led to decisions to develop a more robust system to track adoption using data from the EHR. This included tracking usage patterns of different applications or functions of the EHR.

A Pubmed [6] literature search was performed for information on using audit information to measure EHR adoption. However, very little specific information could be found.

This paper describes the development and implementation of system based on EHR audit information to measure EHR adoption and core functional usage patterns.

Materials and Methods

This analysis was performed using the HELP2 Electronic Health Record at Intermountain Healthcare. Intermountain Healthcare is a not-for-profit integrated health care delivery network which operates 22 hospitals (128,000 admissions per year), employs over 700 physicians working in 170 ambulatory clinics (6,023,000 patient visits per year), and insures approximately 500,000 individuals.

Intermountain's clinical information systems are relatively extensive and have been described previously [7]. Inpatient and outpatient data are interfaced to a longitudinal patient record and stored in the Clinical Data Repository (CDR) [8], the underlying repository for HELP2. Providers access different HELP2 modules for different functionality, including documentation of progress notes, problem lists, medication orders, etc. HELP2, has been in use with periodic updates since 1996. Over 13,000 clinicians use the HELP2 EHR each month to access the records of 258,000 unique patients.

Auditing capabilities are advanced and built into the foundation of HELP2 and the CDR. The purpose of the audit tables is to record the actions of users accessing various forms of patient data. For each encounter table, a corresponding audit table keeps a complete record of all transactions to provide an audit trail. Every time a table is updated, the system makes a copy of the new entry, adds the data elements needed for the audit entry, and moves the copy into a duplicate table reserved for audit purposes only. For instance, each time the main encounter table is modified, the corresponding audit table grows by one row. However, the main encounter table contains only the current data for each encounter.

Audit Data Mart

Early versions of computerized EHR adoption tracking of HELP2 pulled transaction data directly from the production data base, usually during off-peak hours so performance of HELP2 would not be impacted. As usage of the EHR grew, along with the demand for adoption metrics, it was no longer feasible to access the production system for adoption metric data. Preliminary analysis of audit logs showed that the data might be suitable for adoption metrics.

Coincidentally, Intermountain Healthcare's compliance department had designed a small system called the Compliance Audit Database (see Figure 2) that aggregated audit information from the CDR to provide reporting functions without impacting production systems. These reports identified users that accessed patient records in the event inappropriate access was reported or suspected.

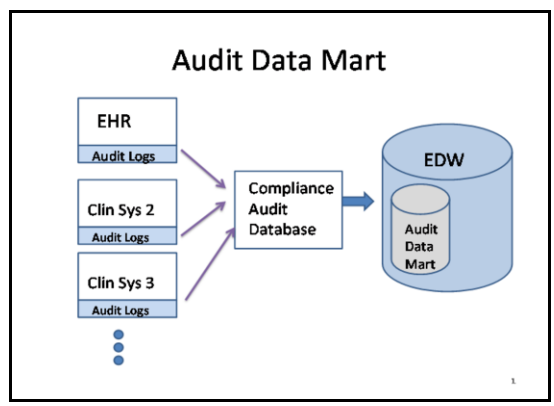

Figure 2- Flow of data from the EHR audit logs to the Audit Data Mart within the Enterprise Data Warehouse and

Early adoption metrics were pulled from the Compliance Audit Database. However accessing audit data from the Compliance Audit Database was problematic for several reasons. The audit data was abstract, and audit table analysts were often necessary to help create meaningful queries. Also, accessing aggregated data across multiple patients was very time consuming as the tables were not indexed ideally for the type of analysis necessary for EHR adoption reporting. There were also security and privacy concerns about accessing audit tables directly because the audit tables were not themselves audited.

To solve these issues an Audit Data Mart (See Figure 2.) was designed with the following goals in mind. Appropriate audit data, scrubbed of unnecessary sensitive information would be loaded from the EHR audit tables or the Compliance Audit Database into data mart tables in the Enterprise Data Warehouse (EDW).

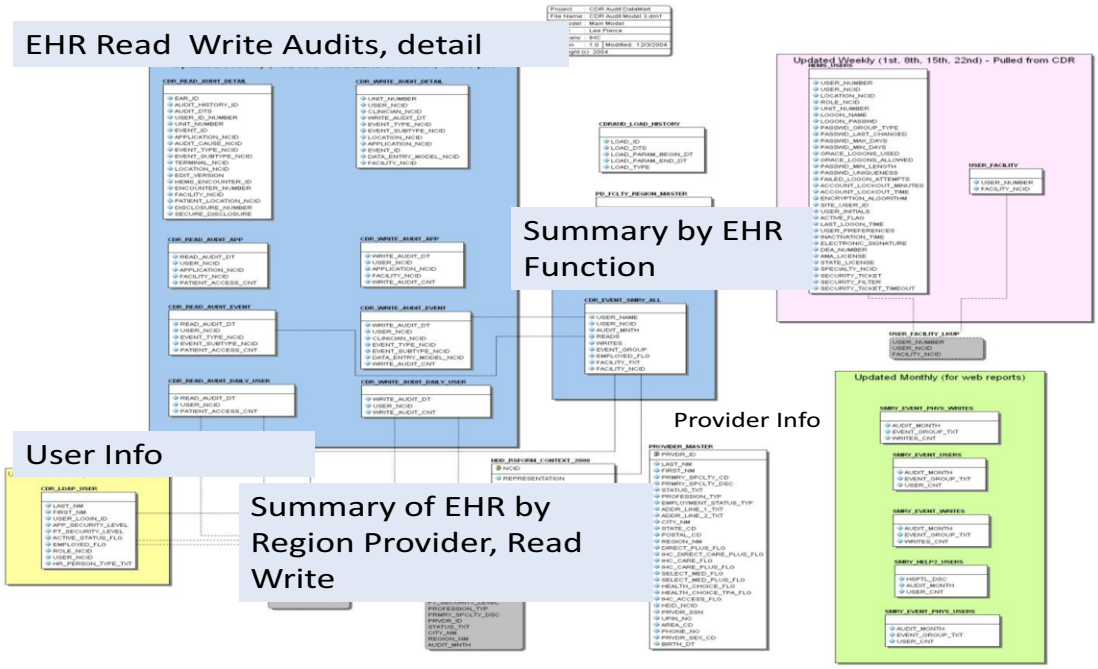

Figure 3 - Entity Relationship Diagrams of Audit Data Mart

Tables would be indexed and optimized for analysis and easy to search. Metadata would be used to describe the content, so analysts can pull data efficiently. Help2 user identification information would be linked to a common user identification scheme, to eliminate the need to match users from other clinical systems. Access to these tables would be audited in the Enterprise Data Warehouse to enable monitoring for security purposes. Access to the audit data mart would be managed by a data steward, and follows access guidelines outlined by Intermountain Healthcare.

The Audit Data Mart can be divided into 4 groups of tables, as shown in Figure 3. EHR Detail Read and Write Audit tables includes detailed information about read and write audits, including patient unit number, application type, data type, etc. User Info is data about the EHR user including name, employment location, role, etc. Provider information includes information about clinicians, including specialty, location, affiliation, etc. Finally, the summary tables aggregate common information into single tables. For example, User name, count of reads and writes per month, role, EHR application or function, etc. Audit data prior to the year 2000 are maintained, so historical reports and trending can be accomplished. The Audit Data Mart can be accessed with SQL or a similar query language tool. The tables are well defined in the metadata of the EDW. Reports can be easily built to answer many EHR adoption questions.

Results

The Audit Data Mart was queried to determine which EHR functions were used most frequently to access patient information for each department within Intermountain Healthcare. Usage of HELP2 EHR functionality was identified for all 836 Intermountain Departments, within 21 hospitals and 160 clinics. The results for the top 25 Departments are shown in Figure 4. The departments are shown in descending order of EHR use. The EHR high-level functions listed include Problems, Notes, Messages, Notifications, etc. This analysis shows the UV218 Emergency Room that the highest HELP2 usage, accessing over 20,000 unique patient records in 90 days, followed by Dixie Clinic and an Internal Medicine clinic, all based within the enterprise. Functions used to access the data include the ED System module, Problem Module, Notes Module, Encounters Module, Allergies Module, etc. This analysis also shows the different patterns of EHR function usage. For example, problem list was accessed on more patients in Dixie Clinic than anywhere else.

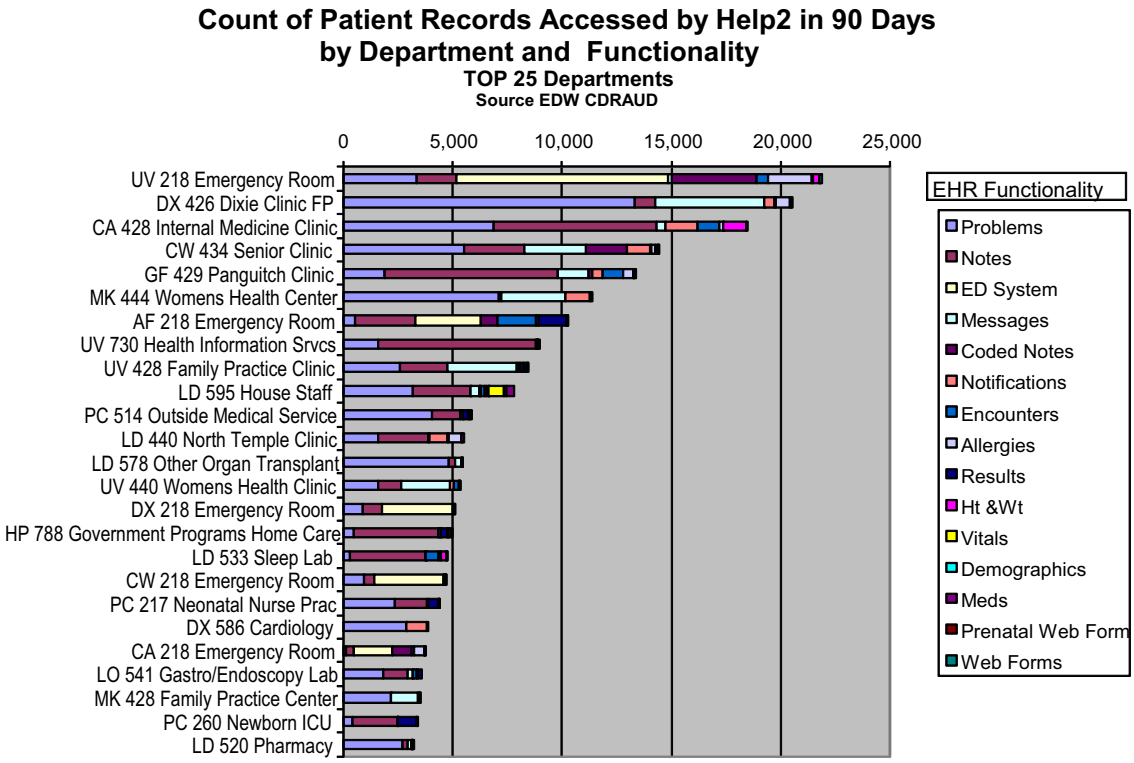

Figure 4 - Count of Patient Records by Department and EHR Functionality

Discussion

Early work on EHR adoption assumed a more or less homogenous adoption model, i.e. that all EHR users accessed the same functionality. Recently research has shown that EHR adoption can be more heterogeneous with users accessing different functions within the EHR [9].

For example, some users adopt more modules and use these modules on more patients. This has been our experience at Intermountain Healthcare [10-12]. Figure 4 shows the different types of EHR use within the top 25 departments. For example, Dx426 Dixie Clinic accessed problems list items on more patients than the UV218 Emergency Room. We have found that adoption metrics from the Audit Data Mart have been critical for tracking EHR implementations at Intermountain. For example, knowing the differing use of Problem List at two sites could trigger an analysis to identify the cause of the low usage. Often, more EHR training is necessary to improve usage of certain modules.

This analysis primarily took advantage of the 'Read Audit' data from the Audit Data Mart, which stores information about how clinical data is accessed. 'Write Audit' data, contains detail about how clinical information is stored. We have used the Write Audit data to identify which modules clinicians use to enter data into the EHR. We expect the 'Write Audit' data to be play a key role in documenting meaningful use of the EHR. For example, we can track which physicians enter CPOE orders, Eprescribing orders, allergies, etc.

The richness and ease of use of the audit data mart has resulted in the ability to rapidly measure EHR usage on a broad scale. In addition, it is easy to customize the reports to meet the needs of various stakeholders. For instance, detailed reports on individual users use of EHR functionality can be done for department use, or high-level summary reports can be run for the entire enterprise. These reports have proven to be useful in strategic planning [10], in tracking progress of current EHR implementations with our employed and non-employed physicians. We foresee this methodology being critical to support the documentation of 'meaningful use' of EHR functionality required by the ARRA incentive laws.

Limitations

There are limitations to using Audit repository data to measure system usage. Audit repository data was not designed to be used for measuring EHR adoption. Understanding the audit

table update process is key to transforming the audit table date into information that can be used for tracking EHR adoptions and functional use. For example, audits of some Help2 module screens such as Clinical Notes Review produce a row in the audit table for each clinical note summary that is shown on the screen. If 25 notes are shown to a user, there are 25 audit table rows written to that audit table. For adoptions and usage metrics, this detail is overkill. One method of managing this is to count only the first 'read' event per patient , per user, per module, instead of counting all 25. What is important is defining the methods of managing the information. We store these transformations in the metadata associated with the Audit Data Mart.

We have found other limitations to using the audit data. For example, some data is just not collected by the audit system. For example, the audit data mart and HELP2 audit data do not contain terminal-specific location information. Therefore, it was not possible to attribute events to a specific terminal or facility. To identify the location of Read Events and Write Events, users must be linked to the location identified by their human resource employment record.

Validation of Audit results

Validating the audit data mart data is critical to success. We shared our adoption metric results with a small sample of departments in order to make sure that our results made sense. We interviewed individual users and asked them which EHR functions they used, and to what extent. In each case the departments' feedback indicated that the audit data mart reports accurately represented their behavior and EHR usage.

Conclusion

This paper describes a method of EHR adoption measurement which capitalizes on audit logs, which are often common components of modern EHRs. This method has been used successfully at Intermountain Healthcare, a large integrated delivery network, to identify EHR usage patterns by functionality within the enterprise. This methodology will likely play a key role in documentation of 'meaningful use' of EHR functionality required by the ARRA EHR incentive laws.

Acknowledgments

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