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Clinical Benchmarking Enabled by the Digital Health Record

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Abstract

Office-based physicians are often ill equipped to report aggregate information about their patients and practice of medicine, since their practices have relied upon paper records for the management of clinical information. Physicians who do not have access to large-scale information technology support can now benefit from low-cost clinical documentation and reporting tools. We developed a hosted clinical data mart for users of a web-enabled charting tool, targeting the solo or small group practice. The system uses secure Java Server Pages with a dashboard-like menu to provide point-and-click access to simple reports such as case mix, medications, utilization, productivity, and patient demographics in its first release. The system automatically normalizes user-entered clinical terms to enhance the quality of structured data. Individual providers benefit from rapid patient identification for disease management, quality of care self-assessments, drug recalls, and compliance with clinical guidelines. The system provides knowledge integration by linking to trusted sources of online medical information in context. Information derived from the clinical record is clinically more accurate than billing data. Provider self-assessment and benchmarking empowers physicians, who may resent "being profiled" by external entities. In contrast to large-scale data warehouse projects, the current system delivers immediate value to individual physicians who choose an electronic clinical documentation tool.

Keywords:

Data warehousing, profiling, guidelines.

Introduction

Physicians need data about their patients and practices to respond to business pressures from external sources, such as payers, government regulators, and affiliated healthcare delivery organizations. These pressures are creating a need to report aggregate information from patient records. Physicians in ambulatory settings using paper records are ill-equipped to respond to these pressures. For example, how many office-based physicians have enough information to predict how well they are meeting US Health Employer Data and Information Set (HEDIS) measures? As a result, third parties who may audit physician performance rely on the only available automated systems in most clinics – practice management, or office billing systems -- to capture data for "productivity" profiles. These sources are secondary to patient care and do not accurately reflect case mix, utilization, or outcomes. In addition, because these analyses and reports are not available to the physician at the point of care, there is no actionable information at where and when it can make a difference for physician decision-making. Physicians resent "being profiled" and often reject the profiles themselves as misrepresenting their activities [1].

Customer service and patient safety are also driving the need for better clinical reporting in the ambulatory setting, for the purposes of improved disease management, preventive care programs, increased awareness of medication safety, and clinical quality improvement [2]. With the paper-based medical record, physicians are ill-equipped to respond to these pressures even though they may be more 'clinical' in nature. Simple procedures like contacting all patients taking a medication which has had an alert and communicating the need to discontinue the medication are nearly impossible with the paper-based record.

In 1999, there was a 500% increase in the number of electronic record systems implemented in large provider organizations [3]. Penetration of electronic patient records into the office-based practice environment of smaller provider organizations has been less rapid. Independent physicians often cannot afford the time, expense, and staff to implement and maintain complex electronic systems. Lightweight web-enabled charting, prescribing, and lab ordering tools, however, offered by application service providers (ASP), are a less complex, lower cost approach to improving clinical record management. Such tools may be used by the solo practitioner, small groups, or individual doctors in a delivery system that has not yet implemented an enterprise electronic medical record (EMR). These tools are available on a monthly subscription basis, with minimal hardware and networking requirements, and simple usage characteristics.

Some clinical documentation tools allow free text entry of patient histories and the clinical narrative combined with

structured clinical lists (problems, medications, orders, and clinical observations). Some systems also provide guidance for US Healthcare Finance Administration (HCFA) evaluation and management coding (E&M), which helps doctors "right code" their visits according to HCFA standards. The key advantages of clinical documentation tools for the physician are complete readable documentation, secure ubiquitous access enabled by the web, and easy integration into a partially paper-based system. These systems are also a source of rich clinical data. These data may be aggregated and made available to empower physicians with reports that help them understand their patient population and overall practice of medicine.

Materials and Methods

A hosted clinical data mart is provided to physicians who subscribe to a web-based clinical documentation tool (Medscape Encounter, Hillsboro OR USA). The data mart is called Practice Profiles, has been available to subscribers since March 2000, and is now in version 2.

Data Source

Physicians subscribe to a web-enabled application service and download a lightweight clinical documentation tool written in Java. The tool tools allows the user to create new chart notes , update/edit charts, and upload the chart to a secure data center or "chart room" (fig. 1). The clinical documentation tool operates in standalone mode (disconnected from the Internet), but users are encouraged to upload/check in their charts nightly and check out only the charts they will need for the day.

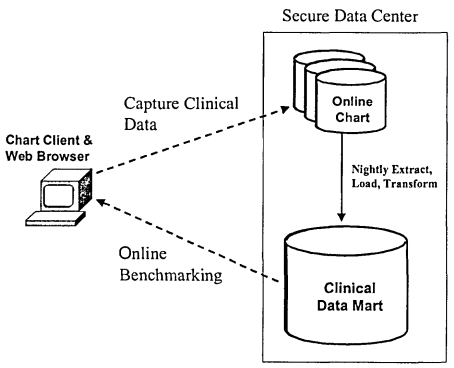

Figure 1. User environment and reporting system architecture. Providers use the charting client to document the clinical encounter. Online benchmark reports are provided via a standard web browser.

Data Preparation and Data Staging

The data is staged in a separate reporting database inside the secure data center. Each night, server-side programs inspect the chart room for new or modified chart data (also know as "deltas" or changed data). Only the deltas are pulled across into the reporting data mart. Terminology normalization and mappings to external coding schemes including International classification of diseases (ICD9), Current Procedural Terminology (CPT), and FirstDataBank (San Bruno CA, USA) drug indications, are performed by a second server-side process. The data mart itself consists primarily of a star schema with a "factless fact table" [4], which underlies most reports. The dimension tables consist of problems, medications, orders, patients, providers, services, and time. Drug utilization reports requiring the association of problems and their indicated medications, use an external table obtained from FirstDataBank.

Terminology Normalization

The clinical documentation tool combines free text entry of histories and narratives together with structured clinical lists (problems, medications, orders, and observations). Providers may make use of extensible standard lists, which allow them to enter items with codes. However, the users are not required to use standard description nomenclature or to assign codes, and the majority of entry terms are user generated.

The entry terms are harvested from the Encounter database, and stored in a terminology server as user interface vocabulary representations. The entry terms were analyzed to determine their frequency of use. The most commonly-used strings were assigned the highest priority as items to map. The many variants of user entered representations for a given clinical concept were grouped together and assigned a concept identifier (fig. 2, Strings that Map to the Concept of "Coronary Artery Disease.").

ARTERIOSCLEROTIC CORONARY HEART DISEASE
ASCAD
CAD
CAD STABLE
CAD UNKNOWN STATUS
CAD,RECENT ANGIOPLASTY 2 WEEKS AGO.
CAD--GRAFT OR LIMA
CAD--NATIVE VESSEL
CORNARY ARTERY DISEASE
CORNARY ARTERY DISEASE S/P CABG
CORONARY ARTERY DISEASE
CORONARY ARTERY DISEASE - CATH WITH MYOCARDIAL BRIDGE IN 96
CORONARY ARTERY DISEASE SP CABGX2
CORONARY ATERTY DZ
Coronary artery disease s/p PTCA
Coronary artery disease stable
Coronary heart disease
coronary disease
coronary heart disease
history CAD

Figure 2. Strings that Map to the Concept of "Coronary Artery Disease."

Each clinical concept is assigned a meaningless concept identifier, and one of its representations is flagged as the default. In addition, each concept is assigned to one or more functional domains, e.g. problem, medication, procedure. The dimension tables in the star schema are populated with the default representation and concept identifier. Queries were aggregated at the level of concept identifier. The user sees only the default representation in the reports, not the many variants of their entry terms.

Security, availability, and scalability

The data center consists of parallel load-balanced web and application servers providing a secure front end to the chart room database. The production chart note data is updated as often as the users check in their charts to the chart room. Nightly extraction and data transformation routines are used to populate a separate reporting database in the data center. This dedicated reporting database is supported by a high-availability server, and the data warehouse performance is not negatively influenced by activity on the production chart room. Individually identifiable patient data is only accessible to the physicians who created it. No one but the physicians themselves are allowed to access their profiles, using secure hypertext transfer protocol (HTTPS) with 128-bit encryption.

Personalization

The chart room is a secure website. The user logs in and obtains personalized reports bearing the provider's name. Reports are presented to the user in a menu listing functional types such as disease management, utilization, productivity, and demographics.

User Interface

The system offers both basic profiles and reports integrating other knowledge sources. The basic personalized profile reports include simple lists of problems (diagnoses) with patient counts, medications used, orders, visit types (based on E&M code) and patient demographics. From the basic reports, users can drill down to disease management information embedded in the advanced reports for selected diagnoses, via a disease management page which launches the user to either treatment guidelines or a lookup of the medications utilized to treat a given disease. From the disease management page, the user can also "drill out" to related information on the web such as additional guidelines, current authoritative articles, or information about enrolling patients in current and upcoming clinical trials.

Drug Utilization Inference

While new reimbursement and safety regulations may call for the provider to explicitly document drug indications in the chart, it is not yet common practice. Most drugs are prescribed without an explicit connection made between indication for therapy, and prescribed medication. However, it is valuable to the provider to know about his own practice patterns, including what drugs are being used to treat problems. To infer indications for drug utilization, we use a drug knowledgebase to make the connection (FirstDataBank). This retrofitting requires the system to make an inference that a given drug was prescribed for a particular problem. For example, aspirin may be indicated for patients with previous myocardial infarction, or for diabetes. The system would associate the aspirin with either or both conditions, in the absence of an explicit indication.

Reporting user interface

Pre-defined reports were written using Java Server Pages (JSP) and deployed on web/application servers. Users access the reports through a standard web browser. The reports consist of diagnosis profiles, disease management reports, medication profiles, orders profiles, and productivity. Productivity reports such as number of notes generated, visit types by E&M code, and procedures ordered can be segmented by time. The system targets a common are of preventive care with an innovative immunization compliance report, allowing the user to quickly identify the population of child and adolescent patients who are due for common vaccines.

The usage model employed by the system takes advantage of common techniques in knowledge discovery, by progressively disclosing more detail as the user asks for it. For example, the first screen of a report may show all data across all patients and the entire data range. The user then may elect to segment the data by for example disease, medication, or time. The resulting count of patients is hyperlinked to a patient list, which ultimately provides access to the deepest report detail -- individual chart summaries.

Knowledge Integration

The browser interface makes it easy to provide knowledge links to recent articles from premium reference content providers such as Medscape, Medline, National Guideline Clearinghouse, ClinicalTrials.gov, and MDConsult in context of the specific disease or medication report.

Discussion

Benchmarks are a common tool used by every business and industry to assess performance, manage best practices, and tailor the business operations to best ensure success [5], [6]. The current system provides a unique capability for clinicians to create and use benchmarks derived directly from their patient records created with an EMR.

Disease Management and Quality of Care

The Practice Profiles benchmarking system allows the clinician user to better manage many aspects of the quality of care delivered across a population or cohort of patients. For example, the online benchmarking system allows users to easily identify a population of patients who have a particular disease or who are on a given medication. This allows the physician to effectively manage populations of patients in an efficient manner. Quality improvement, or patient safety measures, may readily be applied to the appropriate cohort of patients.

Patient Safety

The ability to drill down from profiles to patient lists is particularly useful in identifying patients who may be affected by drug recalls and warnings. In a paper system, the costs of identifying patients on a given medication make it impractical and documentation gaps may make it impossible to successfully notify all patients who may be on the drug.

Competitive information and income protection

Clinical documentation is potentially the most accurate picture of the actual activities that transpire during patient care. However, physician compensation is likely to be driven by secondary sources of information such as claims and billing records or pharmacy information, rather than by the patient chart. In some cases, (such as HEDIS reporting) paper charts are sampled and viewed as a way of supplementing and verifying payer data on the quality of clinical practice. However, paper chart pulls are a costly, time consuming, and inconvenient means of sampling chart data, as they depend on coordination between the payers and clinics followed by statistical analysis of the sampled data. As described, point-and-click profiles built directly on the clinical documentation are potentially far less costly to both the provider and the payer, and can give a much more complete and accurate picture of the provider's patient population. Payers are evaluating ways to incent physicians to use electronic records as a means of reducing administrative costs, potentially giving them a competitive edge over those who continue to use the paper chart. The benchmarking system gives quantitative credence to those cost-saving measures, by demonstrating productivity and care quality.

Physician empowerment

The advantage of "self-profiling" with the electronic benchmark system is empowerment of the physician to control his or her own data and gain direct insight into his or her own practice patterns, thus warding off a sense of scrutiny by payers and quality managers. As disease management and quality of care measures become increasingly common, the ability for providers to perform periodic self-assessment is key to improving overall performance [7], while helping to increase provider compensation through bonus programs.

Clinical vocabulary and data quality

The vocabulary server database is a metadata store of user interface terms tailored to the needs of Encounter, not intended as a comprehensive medical terminology. Only the representations that were entered by users are processed by the vocabulary server. The conceptual granularity of the user-entered representations are maintained, rather than mapping them to "broader-than" terms. For example, "knee pain, left" is created as a distinct concept, not mapped to "knee pain." This bottom-up approach to vocabulary management allows the useful terminology to grow in scope and coverage over time. Links to external coding schemes, e.g. ICD, FirstDataBank, CPT, and LOINC, are maintained at the concept level. The vocabulary server does not maintain semantic relationships between representations. Rather, the system allows the future creation of links from Medscape concepts to a reference terminology, e.g. SNOMED-RT/CT.

As seen in figure 2 (Strings that Map to the Concept of "Coronary Artery Disease."), a wide spectrum of alternative usages and misspellings are tolerated by the system for the most common entry terms. For physicians who are not used to typing or who will not add problems, medications, and orders onto a separate clinical list, the ensuing profiles would potentially suffer from a lack of completeness. Studies of user documentation patterns in the current system could indicate whether users are consistently documenting problems and medications for each patient.

Most physicians are not business-savvy or benchmark-oriented

Physicians in managed care settings are familiar with the experience of receiving "report cards" that assess their performance based on utilization and productivity. These assessments are used to document and improve quality, outcomes, and physician performance by analyzing costs, resource utilization, and performance indicators. Typically retrospective report cards occur at long intervals, and contain numerous performance measures with large amounts of aggregate data. However, physicians often find the report card format difficult to interpret and translate into action[1]. Performance reviews involving groups of physicians in this scenario have often had a de-motivating affect on physicians and result in an antagonistic relationship with the employers or payers. Many believe "my patients are sicker" and regard payer-generated profiles as unfair. Indeed, having as few as 1-3 poorly-controlled patients can skew an individual doctor's report card [8]. Some physician groups have issued recommendations on the methods and appropriate use of profiles [9], but report cards are ultimately designed for the benefit of payers and managed care organizations and often hold little intrinsic interest for the clinician. A preferable approach is to provide frequent, clinically-targeted performance information in a private setting to empower the physician to monitor his or her own progress to specific clinical goals. This approach is even more powerful when there are periodic rewards for performance, such as financial incentives for achieving predefined thresholds on quality of care measures. An effective reward system may give providers more incentive to review standards of care, do more complete documentation, and monitor individual progress toward defined goals.

Knowledge Management

Current trends in knowledge management (KM) for healthcare enterprises were recently reviewed by Strawser [10]. KM represents a methodical approach to best practices, providing a means to achieve improved clinical work processes and clinical decision making through portals or "digital dashboards." Commonly-used tools for KM include "centralized search capability, indexing and categorization, content analysis & application, and data analysis." Our benchmark system incorporates commonly-accepted clinical treatment guidelines and provides easy-to-interpret feedback to the physician with regard to specific performance on those guidelines. The system has the capability to be shared across a practice or organization. Knowledge management attempts to make a difference in the search for information by systematically integrating data from a variety of sources. The system's reports, database and vocabulary model, links to disease and drug

database search engines, plus clinical guidelines put all these tools in the hands of the office-based practitioner.

Clinical decision support at the point of care

The benchmarking system is intended as a retrospective benchmarking tool, a way for a provider to assess the overall patterns seen in the office-based practice. In contrast, clinical decision support systems (having the ability to prospectively trigger alerts to the physician about preventive care or disease management) are designed to be used at the point of care in the course of treating the individual patient [7], [11]. Clinical decision support systems are often based on guidelines similar to those used in our retrospective disease management reports. However, in the physician's daily use of electronic charting tools, it is not certain that the documentation of the clinical encounter takes place at the same time as the patient is available. Therefore, as a component of an overall disease management program, the ability to report retrospectively on compliance with commonly-accepted guidelines has the potential to modify physician behavior in tandem with alerts and reminders. In fact, a data warehouse architecture may prove to be the most valuable source of integrated, quality controlled data for point-of-care decision support as well as retrospective reports[7].

Conclusion

Our vision for the digital health record is to provide low cost integrated documentation, decision support, prescribing, ordering, lab results, and embedded knowledge sources at the point of care. This range of functionality, properly deployed, could ensure benefits to the physician and patient such as helping to meet standards of care and increase patient safety. For example, the digital health record could recognize a patient with elevated LDL cholesterol, trigger an embedded treatment guideline at the point of care, allow provider to quickly document the current findings, perform risk stratification, suggest treatment options, automate prescriptions and orders, print a patient handout, and follow up with electronic messages about progress toward treatment goals.

The future vision for clinical benchmarking includes full coverage of clinically-relevant data for quality of care and physician productivity. The end user may pose a variety of population oriented questions to gain insights across all patients. For example, show the count of all patients with diagnosis of hyperlipidemia. Of these, how many are well controlled per accepted treatment guidelines, and how many of those who are not controlled are on appropriate therapy? How many on therapy are using the most cost-effective medications? What is the average reimbursement level to the physician for an office visit in which hyperlipidemia was evaluated? What is the potential cost savings for treating at-risk patients with cholesterol lowering drugs, thereby averting serious health risks?

The current system represents a step toward such a vision, but integration among the various components of the extended solution remains a key challenge. Links to critical information about a given patient across the continuum of care (e.g. hospitalizations, medication compliance information) are rather difficult to obtain. Currently, the capability to order laboratory tests and obtain results is under development. We advocate a stepwise approach to helping physicians adopt the digital health record, by gradually introducing services that they are prepared to accept while demonstrating incremental value with reporting and benchmarking capabilities.

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