Building a Results Review System: A Critical First Step in Transitioning from Paper Medical Records

Wayne A. Wilbright, MD, MS¹, Robert Marier, MD, MHA¹, Amir Abrams¹, Luis Smith¹, Duc Tran¹, Alan Thriffield, Jr.¹, Michael K. Butler, MD, MHA, CPE¹, Elmore Rigamer, MD, MPA², Clayton Williams MPH², Robert Post MD²
LSU Health Sciences Center¹, Louisiana Public Health Institute², New Orleans, LA

ABSTRACT
Electronic health records (EHRs) are valuable tools for efficiently delivering safe and effective care, yet the majority of providers continue to rely on paper based systems. Cost is a significant barrier to adoption. Providers unable to afford a comprehensive EHR may still be capable of taking a less costly first step toward improving quality and safety with less aggressive yet effective clinical information system strategies. We identified a single, clearly definable, clinical information need: Improving the delivery of results and reports. We built a results review system to improve the efficiency and reliability of access to clinical information for providers working in the New Orleans safety net for the under/uninsured. We measured provider satisfaction with clinical information delivery systems before and after implementation and analyzed the rate of adoption and ongoing system utilization. Providers expressed increased satisfaction, and showed rapid adoption and an ongoing high rate of utilization over time.

INTRODUCTION
The benefits of EHRs, computerized physician order entry (CPOE), e-prescribing and clinical decision support (CDS) systems are well established.¹,²,³,⁴,⁵,⁶,⁷,⁸ These clinical information systems (CISs) are essential in achieving the Institute of Medicine’s (IOM) goals for an ideal health system: safe, effective, patient centered, timely, efficient and equitable.⁹ Yet, the reality is that the majority of providers continue to use paper based systems. Less than one third of the $20 billion in US healthcare IT expenditures in 2001 was spent for clinical systems.¹⁰ Only 20% of hospitals and 5% of physician practices have implemented EHRs, and fewer than 5% use CPOE or have implemented e-prescribing.¹¹,¹²,¹³

The slow rate of adoption can be attributed to a variety of organizational, process and technology barriers, such as clinician resistance, immature vendor systems, delays in standards adoption, underdeveloped IT strategies or lack of administrative support; however none seem as overwhelming as the barriers of cost and limited financial incentives for change.⁸,¹⁴ Purchasing a “full function” EHR with CPOE and CDS may not be financially feasible for many HCOs. The cost for a large HCO to implement an EHR could range between $10-50M, or more, over 5 years.⁸,¹⁵ The financial obstacles are especially challenging for safety net providers serving the under/uninsured and medically underserved.

President Bush has set a goal that all Americans will have an electronic medical record in 10 years. While this gives hope that federal funding sufficient to overcome financial barriers may soon be available, HCOs, including safety net providers, must address quality and safety now with less aggressive but effective CIS strategies. For the majority who cannot afford a “full function” EHR, less comprehensive approaches aimed at improving the delivery of critical clinical information may be effective and affordable alternatives. A critical-systems-first strategy that gives clinicians efficient access to basic information they need in daily practice (i.e. results) but yet is designed to allow incremental growth to an eventual EHR is a way to overcome what seem to be insurmountable obstacles. The IOM Committee on Data Standards for Patient Safety has defined eight core EHR functionalities: health information and data, results management, order management, decision support, electronic communication and connectivity, patient support, administrative processes and reporting, and population health management. The committee observed that functionality in any of the core areas, independently or in combination, has positive effects on the quality of patient care.¹⁶ This observation validates an incremental approach as a reasonable, and perhaps requisite strategy, when financial constraints prevent accomplishing the more expensive alternative.

We describe the building and implementation of the first core EHR functionalities for Louisiana’s public hospital system and its safety net provider partners in New Orleans. We adopted, in the face of limited resources, a CIS strategy to address critical clinical information needs not being met by paper systems and disparate legacy technologies. Our strategy is based on establishing a reliable and scalable CIS foundation, meeting urgent clinical information needs...
of safety net providers by implementing a results review application, and planning for the addition of capabilities to meet other clinical information needs that leverage the foundation in a stepwise manner. We measured provider satisfaction with clinical information delivery systems before and after implementation and analyzed the rate of adoption and ongoing utilization of the new system.

METHODS

Study Setting
New Orleans has a population of 484,674; of which 27.9% live below poverty level. LSU Health Sciences Center (LSUHSC) operates the State’s ten-facility public hospital system, which cares for approximately 1 million patients. The Medical Center of Louisiana (MCL) in New Orleans is the largest of the ten facilities, and serves as the sole tertiary care facility for the community’s under/uninsured. MCL is the principle teaching hospital for the LSU and Tulane Schools of Medicine, and has 2,421 faculty and resident MDs, 916 nursing staff and 694 beds. In 2003, there were more than 25,000 inpatient and more than 500,000 outpatient visits to MCL. Approximately 75% of patients had Medicaid-only (20%) or no health insurance (55%). Many patients receiving diagnostic testing and specialty care at MCL obtain primary care services in a network of community health centers (CHCs). Together, the CHCs and MCL represent the safety net providers for the under/uninsured of New Orleans.

Determining the Most Critical Information Needs
In late 1999, a new laboratory information system implementation at MCL disrupted clinician access to lab and pathology results. This event created an opportunity for a newly hired informatician to meet with clinicians about information system concerns. The clinicians were dissatisfied about:

- Difficulty accessing results on a slow, hard-to-use and non-intuitive system devoid of historical data
- Inefficiency of accessing multiple system silos (pathology, lab, radiology, paper medical record) to obtain information on a single patient
- Unavailability and incompleteness of the paper medical record when needed for decision making
- Delays in getting “basic” clinical information (results, discharge summaries, procedure notes, medication/allergy lists) for decision making
- Redundant registrations and duplicate medical records limiting completeness of information
- Incomplete information causing delayed diagnosis and treatment, redundant test ordering, patient risk, and patient/provider inconvenience

They expressed that an efficient, reliable and easy-to-use system providing access to laboratory, pathology, radiology and other basic patient information was critical to providing effective and timely care at MCL. At about the same time, clinicians at CHCs expressed similar information concerns, stating that “fewer than 20% of results and reports from MCL were received after referral.” They expressed a pervasive opinion that the inefficiency of paper based systems transmitting results and reports from MCL was hampering quality and timeliness of patient care.

Design and Development
We set forth to build a system to directly address the information problems identified by clinicians. Our goal was to efficiently and reliably deliver clinical information and establish a strong foundation on which we could incrementally build functionality.

We met regularly with a group of 10-15 clinicians (resident and faculty MDs and nurses) to design the application. The clinicians’ design ideas were prototyped and brought back at subsequent meetings for feedback and further discussion. They defined specifications for information content, presentation, and ease-of-use. They specified the application: (1) serve as a single access point to all electronically available clinical data; (2) organize presentation in a patient-centric format; (3) provide quick access to basic clinical information that could assist with decision making in the absence of the paper record; (4) provide the status of ordered tests as pending or final to reduce the potential of redundant test ordering; (5) provide where possible historical data reducing the need to access legacy systems at time of deployment; (6) be accessible anywhere including from home; and (7) have protections for privacy and confidentiality not provided by the legacy systems.

We translated the design specifications into four foundational components – a clinical data repository (CDR), a master patient index (MPI), an HL7 interface engine and an authentication and access control system – collectively referred to as SMaRDI or Shared Medical Record Data Infrastructure and a Web based results review application called CLIQ or CLinical InQuiry.

The SMaRDI CDR receives, from a variety of disparate legacy systems, clinically relevant data in real time: demographics, insurance status, admission/discharge/transfer, visit history, general and reference lab, microbiology, blood bank, pathology, radiology, cardiology, electromyography, outpatient pharmacy, admission H&Ps, discharge summaries, operative notes and selective outpatient notes. At deployment,
the CDR was pre-populated with more than one year of historical data from each legacy system, whenever possible, to maximize its immediate clinical utility and ease the transition for clinicians from legacy system interfaces. The logical structure of the CDR places the patient at the center of the data model and facilitates the presentation of information to the clinical user in a patient-centric format.

The SMaRDI MPI utilizes an in-house developed algorithm that automatically analyzes live registration data and compares demographic data elements to uniquely identify patients and potential duplicate records. When a potential duplicate is identified, the MPI assigns a score rating the likeliness that the duplicate records belong to the same individual, and presents the information via a graphical user interface (GUI) to medical records personnel for review and possible reconciliation. If reconciliation is appropriate, all of the patient’s data in the CDR is linked to a unique identifier; making a complete set of data available to clinicians.

The SMaRDI HL7 interface engine receives legacy system data transmitted in HL7 message format via multiple, simultaneous, real time data interface feeds. Arriving messages are immediately processed and sent to the CDR and MPI. SMaRDI receives more than 50,000 HL7 messages per day and houses more than 29,500,000 results and reports. The data are available within seconds of transmission from the originating system for clinician access through CLIQ.

CLIQ is a customized Web-browser user interface that permits clinicians to review all patient information from any network-enabled computer, organized and collated in a patient-centric format, thus eliminating the need for clinicians to access disparate legacy systems to review the collection of results and reports available on an individual patient. CLIQ maintains a user profile with user-controlled viewing options and a “My Patient” list function, reducing the need to repetitively search for a patient’s record. CLIQ is available to authorized clinicians at MCL and the CHCs. The SMaRDI and CLIQ security architecture provides the necessary access controls and audit trail functions to comply with HIPAA regulations and institutional privacy policies.

**Study Design**

The study has two components: an analysis of clinician satisfaction with clinical information delivery systems before and after CLIQ implementation and a descriptive analysis of CLIQ utilization since deployment. The satisfaction component was designed to measure clinician satisfaction (MDs and nurses) with clinical information delivery systems at MCL, overall and across five subscales – usefulness, accessibility and timeliness, quality of the retrieved information, ease of use, and overall user reaction to systems – before and after the implementation of CLIQ. Satisfaction was measured using an in-house developed survey instrument of thirty questions with Likert-type scales and two measurement points: 2 weeks before and 3-4 months after introduction of CLIQ. A 5-member panel of physicians, informatics professionals and clinical administrators assessed the survey’s content validity.

After successful piloting and reliability testing (Cronbach’s alpha = 0.94), a paper version of the survey was administered to clinicians during departmental meetings. The measurements were carried out in February and July 2003, using two separate convenience samples of users. The questions on the pre- and post-questionnaire were identical, and the same clinical departments were surveyed at both measurement points. Only those resident clinicians working for at least eight months were surveyed. We arrived at overall and subscale scores by combining a predetermined series of questions. Specifically, the overall score was the mean of all the questions and a subscale was the mean of a series of questions related to one topic. Since subscales were derived as a mean of a series of questions and are likely to have more of a range of values than a single question, we performed unpaired t-tests to determine the differences between the two measurement points.

The utilization component was designed to determine trends in the adoption of CLIQ and to view longitudinally ongoing acceptance of the application as a function of utilization. All resident and faculty MDs and nurses were provided access to CLIQ in March 2003. A 30-minute CLIQ training overview was provided to potential users during pre-existing departmental meetings in the 4 months following implementation. The use of the system was voluntary. All legacy information systems remained available to clinicians during the time period of analysis. SMaRDI audit trail logs were used to determine the utilization statistics.

**RESULTS**

**Satisfaction Data**

Two hundred seventy four surveys were completed: 173 (63%) before and 101 (37%) after CLIQ implementation, with a return rate in both groups of greater than 90%. Respondents were mainly from MCL, less than 40 years old, resident or faculty MDs, and worked in pediatrics or internal medicine. The
majority of participants rated their computer skills as intermediate. There were no significant differences in age, work location, position, specialty or self-rating of computer skill between the two groups. Figure 1 shows the overall mean and subscale satisfaction scores with 95% confidence intervals before and after the implementation of CLIQ.

Figure 1: Mean satisfaction scores (7-point Likert)

![Mean satisfaction scores chart]

Utilization Data

Four hundred ten clinicians attended a CLIQ training overview between March and June 2003. By June 30, 950 unique clinicians (more than twice the number trained) had used CLIQ. The number of unique users and average daily utilization of CLIQ has continued increasing each calendar quarter since deployment (Figures 2 and 3).

Figure 2: Unique Users Accessing CLIQ

![Unique Users Accessing CLIQ chart]

Figure 3: Daily CLIQ Utilization

![Daily CLIQ Utilization chart]

More than 4,493 unique clinicians have used CLIQ since deployment, with a current weekday average of 925 unique users logging in approximately 3,350 times, and accessing approximately 4,000 unique patient records more than 15,000 times per day. The CLIQ MPI has facilitated the identification and reconciliation of more than 6,000 duplicate medical records. CLIQ is now available at 20 CHC locations in New Orleans.

DISCUSSION

CLIQ and SMaRDI represent the first core EHR component serving the Louisiana’s public hospital system and its partner safety net providers in New Orleans. Improved provider satisfaction and the high adoption and utilization rates attest to its success. Use has steadily increased since inception when measured by the number of users, the number of user logons and the number of patient record accesses per day.

Clinicians have reported verbally and by email several areas where, from their perspectives, CLIQ has contributed positively to patient care. Perhaps the most dramatic are CHC clinicians reporting the “availability of specialty consultation reports, procedure notes and test results performed at MCL has increased from less than 20% to 100%.” Clinicians have indicated that CLIQ has significantly reduced the time to access patient information, contributed to reducing the ordering of redundant tests, and enhanced clinical decision making when the paper record is unavailable. MCL administration has reported CLIQ playing an integral role in “meeting HIPAA compliance, facilitating the elimination of shadow charts for JCAHO compliance, and contributing significantly to the improvement of day-to-day patient care.”

On the scale of “full function” EHRs able to fulfill all eight IOM core functionalities, we have started small in concentrating on a single, clearly definable clinical information need: The efficient and effective delivery of results and reports to clinicians. CLIQ responds to the providers’ need for a relevant subset of information to support decision making, including patient demographics, clinical results and consultation reports.18,19 McDonald found that implementing only results review/management functionality could significantly impact quality and safety.20 Based on these studies, we believe that presenting clinical information in an easily accessible and clinically intuitive manner through CLIQ has potential to improve care for the under/uninsured in New Orleans.
CLIQ and SMaRDI are the first step in a long range strategy to address critical clinical information needs failing to be met by paper systems and disparate legacy technologies. They are designed with a vision toward future growth, having capabilities to exchange health data across multiple providers, and undergird the development of other CIS components of value to the safety net. MCL and CHC clinicians have defined the next incremental step: Development of decision support functionality providing preventive health and disease management reminders and alerts for abnormal test results.

This experience has taught us several valuable lessons. Technology need not be prohibitively expensive or complex to help clinicians deliver care. Clinicians know the information they need and how they want it presented. Most HCOs have legacy systems with an abundance of clinical information whose value goes unrealized because it is cumbersome to access and interpret. The solution described here solves that issue and we believe is within the reach of most HCOs. We attribute CLIQ and SMaRDI’s success to a strategy that optimized existing systems to meet a specific information need, and our ability to implement designs that were user driven. The combination is economical and effective.

CLIQ and SMaRDI have cost approximately $2.5 million to develop, implement, and maintain over 3.5 years. An estimate of the yearly maintenance cost at current utilization rates is about $0.20 per patient record access. The capitalization costs shrink when one considers that the system will soon be used in four additional public hospitals throughout Louisiana. But perhaps its greatest value is that with it we have taken a first step toward an EHR.

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