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CEDRIC: A Computerized Chronic Disease Management System for Urban, Safety Net Clinics

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Abstract

To meet the challenge of improving health care quality in urban, medically underserved areas of the US that have a predominance of chronic diseases such as diabetes, we have developed a new information system called CEDRIC for managing chronic diseases. CEDRIC was developed in collaboration with clinicians at an urban safety net clinic, using a community-participatory partnered research approach, with a view to addressing the particular needs of urban clinics with a high physician turnover and large uninsured/underinsured patient population. The pilot implementation focuses on diabetes management. In this paper, we describe the system's architecture and features.

Keywords:

Information systems, Chronic disease, Diabetes mellitus, Continuity of patient care, Disease management, Clinical decision support systems, Registries

Introduction

For every 1,000 patients who receive medical care in the US, it is estimated that only one patient receives this care at an academic medical center.[1] Informatics tools specifically designed to assist those clinicians who provide the bulk of patient care in non-academic medical settings could have a tremendous impact on improving healthcare quality. About 125 million people in the US suffer from at least one chronic disease.[2] In spite of this high prevalence, there is consensus that the quality of chronic care in most primary care settings is inadequate.[3] Factors contributing to this inadequacy include deficits in care coordination, lack of information and ongoing support for self-management, poor management of clinical information, and inadequate decision support mechanisms for providers of care.[4] These are further magnified in safety net clinics by high patient-to-physician ratios, limited access to care, lack of insurance, and under-insurance. Wagner's Chronic Care Model identifies clinical information systems as a key component in addressing chronic disease management.[4-6] In particular, clinical information systems that include registries are invaluable for collecting and managing data on chronic diseases, monitoring the health status of a clinical population, and assessing the effectiveness of a clinic's quality improvement efforts.[7] Although most studies of electronic disease registries have examined their use in managed care settings, at least one study has shown that it is feasible to develop electronic disease registries for use in safety net clinics that cater to uninsured and medically underserved patients.[8]

A recent first of its kind comprehensive survey of health information technology use among California community clinics suggests that while 96% of the clinics have implemented a diabetes registry, only 31% report that all providers use the registry.[9] Another study has shown that implementation of disease registries appears to be more successful in clinical settings that already have electronic health information systems versus clinical settings that utilize paper-based systems to record and track patient health information.[10]

Nine suggested features for electronic registries are: a) short training time and easily navigable screens, b) registry systems should be web-based, c) drop-down menus and logic checks, d) HIPAA compliance and adherence to internet security standards, e) support for multiple diseases/conditions, f) incorporation of clinical practice guidelines and reminders, g) support for creation of individual care plans and disease severity rankings, h) ability to print out summary data on care quality and patient outcomes, i) linked to *but not a substitute for* an electronic medical record.[7] An evaluation of three widely used registry systems: the Chronic Disease Management System (CDMS), the Patient Electronic Care System (PECS), and DocSite showed that none possessed all of the nine suggested features.[7] Other suggested features include real-time availability of data, the ability to search for and identify patients at risk for a given clinical condition, web-based links to diabetes guidelines (for diabetes registries), and the provision of feedback to providers to aid preventive and long-term patient care.[11]

Since a goal of some existing registry systems is to spur wide adoption in primary care clinics that may not have dedicated IT staff, they sometimes utilize file-based database management solutions geared for ease of use by lay-people (e.g., Microsoft Access). Unfortunately, these solutions may not offer robust patient data security or be scalable as a clinic's population grows. In addition, some of these registry systems make assumptions about the clinical setting, (for example, assump-

tions about how patients are assigned to primary care providers), that may not correspond with reality, resulting in a need for extensive customization in settings that may not have the requisite IT staff. Recognition of these issues and a desire to address them has led to a unique community-participatory partnered research collaboration between researchers at the Center for Biomedical Informatics at Charles Drew University (CDU) and clinicians at the Family Medicine Clinic of the Hubert H. Humphrey Comprehensive Health Center (HHHCHC). HHHCHC is a Los Angeles County Department of Health Services ambulatory care clinic that has approximately 13,000 annual patient visits and caters to a patient population that is 55% Latino and 37% African American, with 70% or more of the patient population lacking public or private insurance.

The Family Medicine Clinic at HHHCHC has attempted to utilize the Chronic Disease Electronic Management System (CDEMS) in the past for depression management. Recognition of the need for extensive customization of CDEMS was one of the factors that led to the current collaboration between CDU and HHHCHC. A goal of the CDU-HHHCHC collaboration is to develop a computerized system for managing chronic diseases in primary care settings that takes into account the socio-technical barriers to successful implementation and forges academic-community partnerships with community clinics that cater to medically underserved patients. The CDU Electronic Disease Registry to Improve Chronic Care (CEDRIC) is a chronic disease management system that has resulted from this effort.

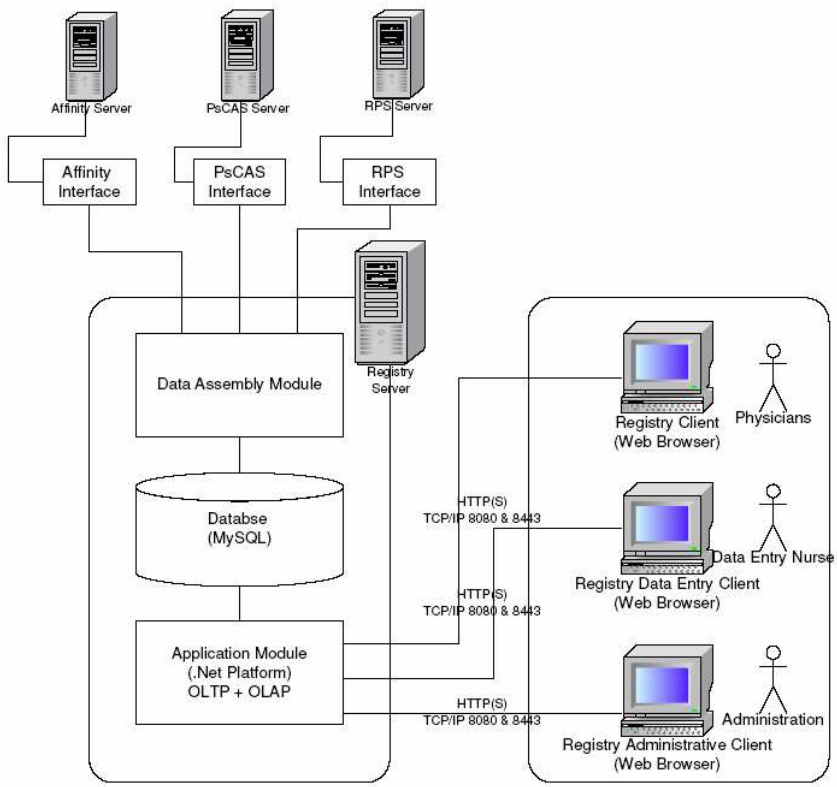

Figure 1- CEDRIC System Architecture

Materials and Methods

Through weekly meetings with clinicians at HHHCHC and researchers at CDU that have continued for over a year, key elements of a system for chronic disease management focused initially on diabetes were identified. Identified needs included: (1) robust system security, (2) access to data and system features based on a user's role as a physician, nurse or administrator, (3) system scalability and flexibility, (4) promotion of evidence-based medicine based on local and national clinical practice guidelines through the provision of automated system alerts and recommendations, (5) the ability to query and summarize pertinent information about an individual patient, (6) the provision of automated periodic reports for physicians, nurses and clinic administrators on patient lab results, care continuity, self-management, Hemoglobin A1c (HbA1c) levels, medications, and comorbid conditions, (7) a HbA1c monitoring service that enables interested clinicians to flag patients whose HbA1c levels they wish to monitor more closely, (8) the ability to track the homeless status of patients as this affects treatment options (the clinic refers homeless patients for social services prior to initiating treatment, since patients receiving insulin need access to refrigerators). While the clinic does not have a fully-integrated electronic medical record (EMR) system, it does have computerized patient scheduling, laboratory, medication, and referral systems. The need to interface with these existing systems was noted. The sociologist on the team, based on interviews with clinic providers and nursing staff, developed a workflow chart to outline the existing clinical flow of patients with diabetes in the family medicine clinic. This was done in order to understand how the CEDRIC system could be best implemented to fit into the existing clinical processes and workflow at the point of care since an understanding of workflow has been a feature of successful diabetes management systems.[12] Charting the workflow required a detailed understanding of the steps involved in a diabetic patient's visit to the clinic. We found that patient visits included the following four steps: 1) registration and financial screening at the general reception desk of the clinic, 2) initial assessment and review of vital signs by the vitalization nurse attendant, 3) visit with the clinician in the exam room, and 4) counseling and discharge by the post-visit nurse-counselor.

Results

CEDRIC has the capability to receive and process daily patient scheduling data and identify those patients with the chronic disease to be managed. The system is designed around a progress note that facilitates standardization of care for patients with particular chronic conditions. It is a database-backed web application utilizing the .Net framework, with C# and VB.Net as the programming languages and MySQL Server 5.0 as the database management system. MySQL was selected for its scalability, platform flexibility, security features, robust transactional support, data warehousing capabilities, and the fact that it is an open-source database management system. MySQL's storage-engine architecture allows the server to be configured for different applications - in our case, to support both the high-volume of transactional queries (OLTP) handled by CEDRIC via users' interactions with the progress note, and the high-speed analytical processing (OLAP) for patient care summaries/reports.

System Architecture:

CEDRIC system components include a registry server and several clients (see Figure 1). Within the server, a data assembly module is designed to collate electronic information from the clinic's health information (Affinity), referral (RPS), and medication (PsCAS) systems. It also checks for data inconsistencies and errors prior to data storage. CEDRIC's server utilizes MySQL for both transactional data processing and to support its data-warehousing environment for generating different clinical care reports. An application module that works in conjunction with a web server retrieves and processes data from the database, stores data to the database, constructs web pages containing requested information for presentation to the user, and implements logic for generating alerts and customized clinic-wide and clinician-specific core measure reports. These reports include patient summary reports, appointment reports for tracking care-continuity and on-demand registry queries. The CEDRIC system has three client categories; physician, nurse and administrator. The system display, including progress note, patient monitoring options, and care report options, is tailored to a user's login role. Users with two roles (e.g., physician and administrator) can interact with the system using either role. Figure 2 shows part of the progress note screen for a physician.

The alerts system is designed to automatically notify physicians when values corresponding to laboratory measurements are out of range, and when referrals and medication refills are overdue. The recommendation system for diabetes management is designed to deliver American Diabetes Association guideline recommendations as well as locally-tailored modifications to these guidelines on the appropriate course of action to be taken in response to alerts.

CEDRIC includes most of the suggested features outlined in the introduction. The feature not entirely implemented is linkage to an EMR system because HHHCHC does not currently have a fully-integrated EMR system. However, CEDRIC is designed to capture and utilize electronic data feeds from the different existing systems that handle patient scheduling, laboratory management, referrals, and medications. CEDRIC would be able to interface similarly with a full-fledged EMR system when the clinic chooses to adopt one.

Discussion

We have presented a summary of CEDRIC, a chronic disease management system developed through an academic center-community clinic partnership. The system implements most of the suggested features for an electronic disease registry as outlined in recent publications on the subject. A key aspect of system development was close collaboration between community clinicians and academic informaticians in identifying and addressing critical issues. We view this close collaboration as key in developing health information systems that are tailored to community health center needs, since many such centers do not employ informaticians, generally have small IT

budgets, and may not have in-house technical support to adapt existing generic IT systems to meet their unique needs. It is our view that information systems that meet the unique needs of community health clinics are more likely to be routinely used by clinicians in those settings. Support for management of chronic kidney disease, cardiovascular disease, HIV/AIDS and depression is planned.

Ongoing activities for CEDRIC include development of a data input module that supports both HL7 version 2.x and version 3.x messaging standards. The new module will accept several different data formats, including: i) HL7 v2.x compliant data, which mostly uses a textual, non-XML encoding syntax based on delimiters, and, ii) HL7 v3.x compliant data, which is based on a formal methodology (the HL7 Development Framework or HDF) and object oriented principles and is encoded using XML.

Future work will include a formal evaluation of the effect of system introduction and utilization on patient outcomes and the quality of care at the clinic. We also plan to make CEDRIC available for use to other safety net clinics.

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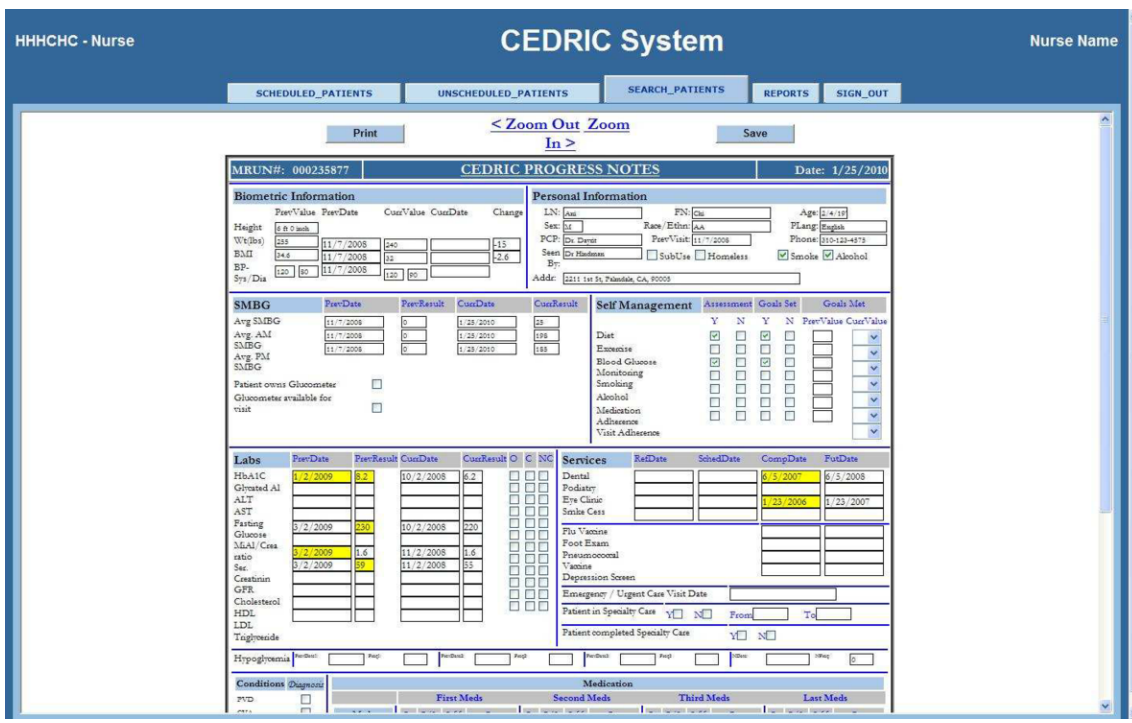

*Figure 2- Partial Screenshot of CEDRIC Progress Note**

**Screenshot does not present data from an actual patient*

References

[1] Green LA, Fryer GE, Jr., Yawn BP, Lanier D, Dovey SM. The ecology of medical care revisited. N Engl J Med. 2001 Jun 28;344(26):2021-5.

[2] Knickman J, Anderson GF. Chronic Care. 8th ed. New York: Springer Publishing Co 2005.

[3] Institute of Medicine. Priority Areas for National Action: Transforming Health Care Quality. Washington, D.C: National Academy Press 2003.

[4] Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. JAMA. 2002 Oct 9;288(14):1775-9.

[5] Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. JAMA. 2002 Oct 16;288(15):1909-14.

[6] Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. Health Aff (Millwood). 2001 Nov-Dec;20(6):64-78.

[7] Kilbourne AM, McGinnis GF, Belnap BH, Klinkman M, Thomas M. The role of clinical information technology in depression care management. Adm Policy Ment Health. 2006 Jan;33(1):54-64.

[8] Hanratty R, Estacio RO, Dickinson LM, Chandramouli V, Steiner JF, Havranek EP. Testing electronic algorithms to create disease registries in a safety net system. J Health Care Poor Underserved. 2008 May;19(2):452-65.

[9] The State of Health Information Technology in California: Use Among Physicians and Community Clinics. Oakland, CA: California Healthcare Foundation; 2008.

[10] Keyser DJ, Dembosky JW, Kmetik K, Antman MS, Sirio C, Farley DO. Using health information technology-related performance measures and tools to improve chronic care. Jt Comm J Qual Patient Saf. 2009 May;35(5):248-55.

[11] Gabbay RA, Khan L, Peterson KL. Critical features for a successful implementation of a diabetes registry. Diabetes Technol Ther. 2005 Dec;7(6):958-67.

[12] Zai AH, Grant RW, Estey G, Lester WT, Andrews CT, Yee R, et al. Lessons from implementing a combined workflow-informatics system for diabetes management. J Am Med Inform Assoc. 2008 Jul-Aug;15(4):524-33.

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