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Integrating Clinical Decision Support Rules Within Clinical Workflows in Rural Community Hospital and Clinics Guides Clinicians

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Abstract

The implementation of electronic health records in a rural setting generated new challenges. The preparation, implementation, and sustaining the operation of the electronic health record requires extensive attention to standards, content design, support resources, expert knowledge and more. The complexity associated with implementing alerts, reminders, and decision support was not taken lightly. The rural community hospital was able to use urban community designed clinical decision support rules (CDSR) to promote safety, prevent errors, establish current evidence-based practice (EBP), or support communication. The paper provides progress on evaluation of the electronic health record implementation using CDSRs. The descriptive research findings illustrate 13 clinical processes supported by 54 CDSRs used in a rural community hospital. The findings provide the goals (as experienced in urban sites) supported in the clinical processes. Rural community hospitals can rapidly overcome the barriers to preparation and implementation as well as sustain use of CDSRs with systemized approach and support structures. A model for implementation of nursing expert clinical decision support to use in workflow processes is presented. Future research is planned.

Keywords:

decision support systems, informatics,
clinical expert systems, formative program evaluation

Introduction

The implementation of electronic health records in a rural setting generated new challenges 18 months ago. This paper shares the formative evaluation of developing clinical decision support rules for a rural setting which was implementing an electronic health record (EHR). From this evaluation, the team shares a developing model to integrate the sciences of computers, information, and health to use medical and nursing evidence in clinical workflow processes. It was confusing to hospital clinical staff when the selection and design of CDSR were a separate piece of the EHR preparations. This meant having separate meetings for many of the components tied to implementing an EHR. In the end, it became easier for clinical end-users to integrate the three sciences upfront rather than overcoming the missed opportunity to include clinical decision support rules (CDRS) in the design of clinical workflow processes.

The formative evaluation on steps in the preparation processes highlighted the need for integration of decisions on CDSR with the redesign of clinical workflows. We will primarily focus on the inclusion of clinical decision support rules, but many other decisions for screen displays for data entry and view, computerized order sets and more design details need to be a part of the work effort by clinical teams when deciding on redesign of clinical workflows. There is nothing easy about the preparation, implementation, and sustaining the operation of the electronic health records. Each step requires extensive attention to standards, content design, training, user support resources, expert knowledge resources and more. Health care informaticians will find as we experienced the need to integrated decisions on design with the decisions on clinical processes. This included clinical decision support rules.

Clinical decision support rules

Clinical decision support was defined as any electronic or non-electronic systems designed to aid clinical decision-making in which characteristics of individual patients are used to generate patient-specific assessments or recommendations that are presented to clinicians to consider [1, 2]. More recently, clinical decision support is defined as "providing clinicians or others with knowledge and person-specific or population information intelligently filtered or presented at appropriate times to foster better health processes, better patient care, and population health" [3]. A clinical decision support rule (CDSR) is one

type of clinical decision support that is defined as an automated evaluation of a pattern of patient and/or clinician data elements that prompt a nurse, physician or other clinician to take an action. The automated evaluations of data patterns are initiated by an event called a trigger. A trigger, also called the evoke event, is defined as patient information generated within the EHR or passing form another application into the EHR system and initiates the automated evaluations of data patterns by aggregating and processing data to prompt the a decisive action. CDSR are used to express therapeutic recommendations, to formulate queries about relevant interventions for a patient, and to assess the effectiveness of a treatment. Decision support expert rules provide clinicians with alerts and reminders, data interpretation and patient diagnoses, patient management suggestions, and clinical protocols. There are multiple data components necessary to activate an expert rule within the EHR.

Methods

The formative and summative evaluation were used to study the implementation of a comprehensive integrated, electronic health record (EHR) system using uniform data standards, with computerized provider order entry, and clinical decision support tools in several rural health care settings (hospital inpatient units, ambulatory care, primary care and specialty clinics). This CDSR study is a part of a larger healthcare information technology study partially funded by the Agency for Healthcare Research and Quality (HS015196-01). In this 3-year study in its final year, 54 clinical decision support rules (CDSRs) are described for the rural hospital and 17 for clinics using a title name, the clinical process using the CDSR, the purpose for the CDSR, the explanation of the rules logic, the evidence supporting the clinical rule's use, the start date for the rules existence in the Cerner EHR, and whether the rule is used only by the rural hospital or is it used among the system by other organizations. The study described the number of times the CDSR was triggered and the number of times the action was completed, cancelled, voided, discontinued or remained as an action by the Cerner EHR system, if captured. The formative evaluation and descriptive findings on the types of clinical processes supported by 54 Expert Rules used in a rural community hospital and 17 for the physician clinics and the goal for supporting clinical processes are presented.

Formative evaluation of preparation

In this section, a formative evaluation describes the preparation processes that existed in 2004. The rural community hospital informatics specialist and clinical leaders received initial education on the steps for preparing for the electronic health record (EHR) in the spring of 2004. This education included learning about many key items. For the focus of this paper, we will discuss the education on redesigning clinical workflows, designing order sets, electronic forms, and selecting CDSRs. The training sessions were part of formal online and in-person training sessions. The preparation steps began by discussing the designing of current state and future state workflows with clinical teams. The formative feedback from informatics specialist and clinical teams were that every item was disjointed and done in "silos" and therefore, it was difficult to internally integrate the pieces of the EHR application. For example, evaluation revealed the workflow redesign was separate form the electronic forms, which was separate from the CDSRs. So the disjointed processes resulted in the design of order sets starting in June of 2004, the review of clinical workflows occurring in August 2004, and the electronic forms in October of 2004 and the steps on selecting CDRS did not begin until December of 2004. Hence, the formative evaluation of the preparation was that every step was disjointed and confusing.

In summary, this process lead to extensive resource use, missed opportunity to select the CDSR options and request new CDSRs. Despite the confusion in the 2004 preparation processes, the rural community hospital received remedial education and was supported in submitting 22 requests for CDSRs (previously operating in 3 urban hospitals) in February 2005. Subsequently, the informatics specialist was able to submit another 25 requests in March 2005, which 13 were previously used in one other urban hospital and 4 were new requests for CDSR. The research team's evaluation of the process for selecting and designing CDSRs for EHR application has lead to multiple recommendations to improve the process. The lead author, Discern Expert analyst worked with others to construct an improved process [4]. In 2005, the authors worked with clinical teams and information system analysts to integrate many recommended CDSRs into the patient-centered clinical workflow processes.

Evaluation of implementation

In this section, a description of the implementation and progressive evaluation of the implementation of Cerner PowerChart EHR which included the Cerner's Discern Expert computer application for providing clinical decision support rules (CDSRs). The activation of the redesigned clinical workflow processes with EHR were implemented during a 24 hours time period beginning July 8th 2005 as planned. This activation included the following components: Cerner PowerChart within hospital inpatient and outpatient settings; Cerner FirstNet Tracking system and PowerNote physician documentation in the Emergency Department; Cerner PharmNet verification and profiling for pharmacy services integrated with robotic bar coding dispensing system and Pyxis dispensing system; HealthQuest patient management quick and pre-registration processes; Cerner Profile Health Information

Management processes for coding, physician electronic signature and record management; and PeopleSoft financial billing and auditing processes. When the EHR was operating on July 9th the clinicians used computerized provider order entry within the Emergency Center and in all other areas. Additionally, nurses and ancillary professionals initiated electronic clinical documentation. Forms were 95% prepared from previous urban hospital use. At time of activation, 53 CDSRs were initiated to complement the already 17 adverse drug event rules using Cerner Discern Expert application. Other types of decision support included 43 emergency room PowerNote templates and over 250 service specific order sets for anesthesia, behavioral medicine, cardiology, cardiothoracic, critical care, EENT (ears, eye, nose and throat), medicine, neurology / neurosurgery, newborn /pediatrics, obstetrics /gynecology, oncology, orthopedics, radiology, specialty procedures, surgery, vascular services. All CDRS remain in operation today.

Results

Eighteen months after implementation, the rural hospital continues to use of 53 CDSRs for medication processes, adult inpatient nursing processes, medical care, and ten other clinical processes. The goals for CDSRs for all disciplines were designed to establish evidence-based practices, prevent errors, promote safety and support communication. See Table 1 for where the CRSR met two of the four goals for clinical workflow processes.

Table 1 - CDSR Goals for supporting processes

Clinical Workflow Process	# Rules	# To Prevent Error	# To Promote Safety
Medication	5	2	3
Medical Staff	4	0	1
Maternal-Child	9	0	0
Pediatric	3	0	0
Nursing Care	13	2	1
Behavioral Health	4	0	1
Nutrition Service	6	0	0
Infection Control	2	0	0
Respiratory Care	1	0	0
Diagnostic Radiology	3	1	1
Rehabilitation	1	0	1
Social Worker	1	0	1
Spiritual Care	2	0	0

Many of the CDSRs were supporting communication and evidence-base practices. Very few CDSR were categorized as other. Each of the CDSRs were analyzed for consistency in triggers over a three-month post-implementation period from July 22, 2005 through October 21, 2005. All the CDSR were functional as the end users expected.

Despite the many challenges, the rural community hospitals and affiliated clinics had overcome the barriers to preparation, implementation and sustaining clinical decision support. The results are rural hospitals and clinics can sustain use of expert rules with systemized support structures, change control procedures, and improved integration.

Discussion

The findings form evaluations to-date suggest integrating the CDSR selection within the decisions needed for clinical workflow processes is necessary to eliminate confusion between components of the EHR. The authors, information system analyst and nurse informatics specialist have initiated steps to design CDSR that are used in most settings to be designed into patient-centered clinical workflow processes. Therefore, the inpatient adult clinical workflow process includes eight CDSRs frequently used with the EHR applications because nurses now use those CDSRs in admission and daily care clinical workflow. The new design for patient-centered clinical workflow processes inclusive of CDSRs were used to prepare two subsequent urban hospitals and one rural critical access hospital for their alike EHR implementations. The change in method reduced confusion and improved the process for implementation. The new method required fewer changes to workflow processes after activation. This has led to the development of a model for CDSRs.

Conceptual model for CDSR in workflows

CDSRs were first integrated within EHRs merely 17 years ago for medicine, yet little has been done to provide guidance on designs and tests for clinical workflow processes. CDSR for nursing care were most prevalent, so the conceptual model for expert clinical decision support rules illustrates: the data sources for information patterns; the nursing workflow; and the evoke events, syntax logic, and action responses central to expert rules See Figure 1. Nursing informatics is built on the framework of three sciences (nursing science, information science, and computer science) operating together to produce nursing process results [5, 6] After observing nine hospitals in selecting, designing, implementing and using expert rules with the electronic health records [4], the model includes the steps that integrate the three sciences for the development of nursing expert rules. The model considers fit with factors used by the Patterson, Nguyen, Halloran, and Ash [7] decision support framework.

In the nursing expert decision support rule model, nurses' input and use of data to support decisions in patient care are illustrated. Data within the EHR are used to trigger the

expert rule operation and to evaluate the data to produce a response. The model (Figure 1) displays within the Information Science: Data Use how data are entered, downloaded from devices or transmitted into the EHR from other applications, as well as the required Computer Science: Expert Rule programming steps for "Event Input" and "Event Action," the "Clinical Decision Support Logic," and "Action Response." Patterson's team [7] also identified need for key contextual and design factor components for decision support. Finally, the "Nursing and Health Sciences: Workflow Process" in Figure 1 represents what Patterson's team [7] described as organization, team and individual factors. The "Change Control Procedures" provide an organization's stability and safety to sustain ongoing operation of expert rules. The clinical workflow processes are dependent on the health, medical and nursing evidence used to articulate team and individual roles with clinical workflow processes. Interdisciplinary roles interact with expert rule in initiator roles that triggers the events and receiver roles to decide the action responses. This model explains the nurse's interaction with the data used for the expert rules through the workflow of the nursing process. Another factor that has not been described in previous models but is central to expert rules is the translation of research evidence into practice by integrating knowledge into each of the steps to produce the best results [8].

The model illustrates the decision-making activities that impact the design and use of the expert rule. The evidence from health sciences guides what clinical findings and responses are collected during patient workflow, the patient care orders available for use, and the available patient diagnostic results to use. These three areas supply the clinical data used to evoke/trigger the conditions of the rule as illustrated by "event input." If not driven by the clinical data from the patient, the rule may be driven by the caregiver's actions of opening the record or performing functions in the electronic record as illustrated with "event action." For example, pharmacists use event action method to receive alerts when entering a record to know they are preparing medications for a patient with a latex allergy.

In summary this model is inclusive of the many components with expert rules for nurses to support the nursing process. The data entry process for the ERH impacts the design and accuracy of CDSRs. If the data are valid, the real-time triggers when working directly with the patient and the electronic record can reduce work in a patient encounter. If reliable and valid, expert rules change the nurse's workflow to facilitate the timely use of information.

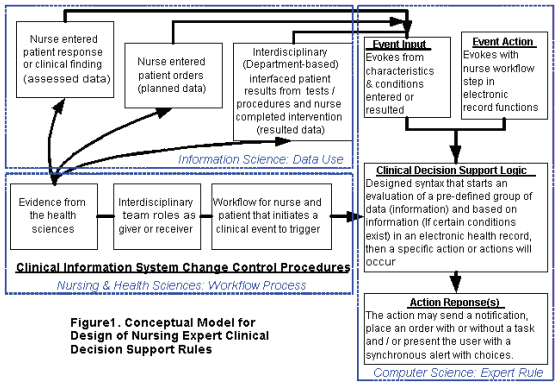

Figure 1 - Conceptual Model for Design of Nursing Expert Clinical Decision Support Rules

Conclusion

Little attention has been given to the clinical workflow processes that involve all the disciplines working directly with the patient. Nurses are the largest group of healthcare professionals that are deciding steps to coordinate and manage multiple patients' care and activities. Nurses rapidly learn and adopt the technology into their nursing workflow processes. Nurses do not hesitate to use the patient data entered or received in electronic health records. Nurses, dieticians, radiology technicians, pharmacists are requesting expert clinical decision support to achieve the four goals to support patient safety, prevent errors, establish evidence in daily practices and improve communication as identified for CDSRs. Nurses coordinate care for many disciplines and the goal to facilitate communication is important. The benefits in efficiencies and cost-effectiveness are unknown and untested with the new technologies that aid nurses' workflow and many other clinicians. This paper begins addressing the workflows for the largest group of healthcare professionals who interact with patients.

Further research is planned to complete the summation evaluation for this implementation in 2006. Other research is planned for testing validity and reliability of evidence-based content design with complex CDRS. This model will be used to test expert rules and guide others in the use of these electronic decision-driving interventions.

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