Computer-Based Physician Order Entry: Implementation of Clinical Pathways

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Abstract. Computer-based physician order entry (CPOE) is a key feature of electronic health record systems. A fully-featured CPOE system, capable of dealing with drug prescription, but also with all the other aspects of patients care, can be used to implement standardized clinical pathways. This classic design can be improved upon by using a workflow engine to drive and bring together the different tasks incorporated in a pathway, including clinical documentation.

Keywords. clinical pathways, order entry

1. Introduction

The National Library of Medicine defines clinical (or critical) pathways as « Schedules of medical and nursing procedures, including diagnostic tests, medications, and consultations designed to effect an efficient, coordinated program of treatment » [1]. This definition puts a clear emphasis on global and operational organization of patient care. Clinical pathways' scope extends beyond basic medical and nursing care and embraces the full span of activities directly or indirectly related to patient management.

Clinical pathways come in many flavors, depending on the class of population they target. Their span goes from generic case management to patient-specific tools. This article will focus on *standardized clinical pathways* and discuss their implementation on a computer-based physician order entry system (CPOE). Standardized clinical pathways are designed for uniform groups of patient, with similar and well known characteristics, following a predictable therapeutic course. Common examples of such scenarios include cataract surgery, hospital stay after vaginal delivery or elective laparoscopic cholecystectomy. Those situations have predictable outcomes, timelines and interventions and goals are standardized for a given population. Standardized clinical pathways have been shown to positively impact both the quality of care and costs, in part by reducing variability in the delivery of care [2–4].

Effective clinical pathways integrate all the aspects of patient care: clinical experience, evidence-based medical knowledge, patients' expectations, operational capacity and limitations of care providers. They allow medical personnel to start, not with a blank state, but with a plan that details the essential steps in patient care,

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describing the expected progress and clinical course of the patients, thus facilitating planning of resources for the whole chain of care. A more thorough presentation of pathways and discussion on audit tools is beyond the scope of this article and can be found elsewhere [5, 6].

2. Context

The Geneva University Hospitals (GUH) is a multi-center organization that federates public health care offering in the Canton of Geneva, Switzerland. It is spread over four main campuses and several additional outpatients clinics. GUH is in charge of primary, secondary, tertiary and outpatient care for the whole region. It admits 45,000 patients a year in its 2,000 beds and handles 850,000 outpatient visits.

GUH's clinical information system (CIS) is a component-based solution integrating commercial offerings on the one hand, and in-house developments, when no commercial solution is deemed satisfactory, on the other hand. The computer physician order entry falls in the latter category and has been developed in the Java environment as an interoperable, standard-based, multiple component architecture. It handles more than 15,000 daily order entries.

3. PresCo (*Co*nnected *Pres*cription)

GUH's computer-based prescription platform, named PresCo, has been designed to accommodate all the different kinds of order needed for basic patient care. Table 1 is a non exhaustive list of the different kind of prescription handled by PresCo.

Table 1. A subset of the different kind of prescriptions handled by PresCo

Type of order
Drugs
Diet
Monitoring
Laboratory tests
Specialized consultations
Radiological exams
Mobilization
Limitation of care
Nursing interventions

Furthermore, PresCo integrates decision-support tools and notification mechanisms (Table 2). For instance, the system can remind users to document and enforce mandatory hospital-wide infection prevention measures; it can flag drug interactions and apply complicated prescription rules in pediatric populations. The system also facilitates grouping of simple orders into *order sets*, such as combined prescription of anticoagulant therapy and its associated coagulation check, or grouping every prescription required in the setting of uncomplicated vaginal delivery.

Table 2. Major functionalities of the prescription platform

Functionalities
Reminders (missing mandatory items, …)
Alerts (interactions, redundant prescription, …)
Information (drug description, guidelines, …)
Prescription-related progress notes entry
Order sets (post-partum admission, acute coronary syndrome, …)
Workflow engine (clinical pathways)

4. Clinical Pathways and the Computer Information System

The architecture of the clinical information system used in the Geneva University Hospitals is particularly well suited to painless implementation of clinical pathways. Build on multiple service-based components, communicating through a message-driven middleware, the CIS functionalities can be thought of as musicians ready to play a musical score: the clinical pathway. This musical ensemble needs a conductor, a workflow engine, which will organize and direct all the components of the clinical information system (orders, lab results, clinical documentation) in a coherent way inside a process of care, from admission to discharge. For the workflow engine, we turned to *JBoss jBPM.* BPM (business process management) offers a programmatic structure for designing transactions and executing those using automated decisions, tasks and sequence flows. jBPM is free software, written in Java, which made it the ideal solution to be integrated into our modular Java-based computer information system. In addition to the workflow engine, it offers simple programmatic interfaces and allows graphical representation of the different milestones of a process [7].

A clinical pathway is a sequence of different phases that represent milestones in the management of a clinical problem. Going from one phase to the next is conditioned on meeting a set of requirements that varies depending on specific clinical pathways. Those requirements can be temporal (time elapsed since admission, for instance), factual (clinical sign, lab value, …) or composite (the association of many different elements). Every phase of the pathway has ties to specific items in the electronic record, such as progress notes, clinical findings and therapeutic actions. Similarly, some important items will be identified, and their variation is going to be recorded, either during a specific phase or for the entirety of the clinical pathway. Pathways can be quite complex. For instance, we have developed a scenario on pulmonary embolism (PE) that combines a diagnostic and a therapeutic pathway. The two pathways are overlapping and can influence one another, until the diagnosis of PE is confirmed or ruled out.

The following example illustrates a simpler case that has been developed to streamline the management of congestive heart failure.
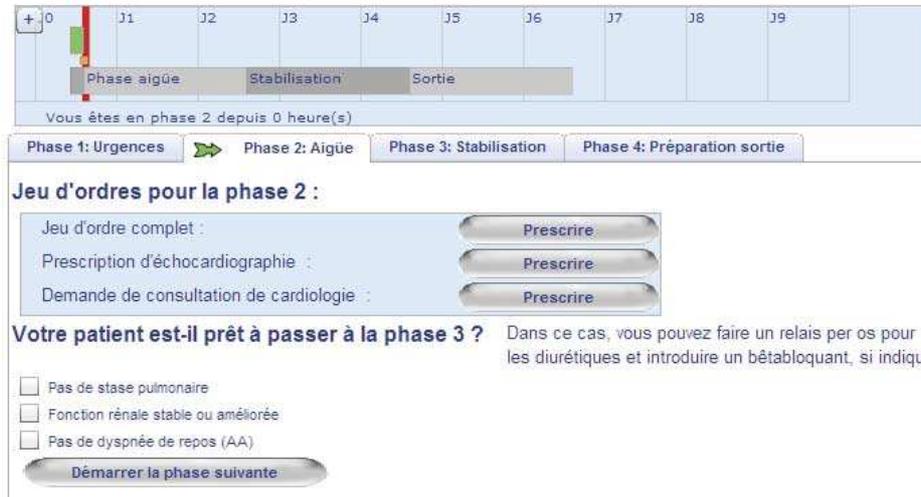
Figure 1. Workflow view and clinical documentation entry

Figure 1 is a screenshot of the global view of the clinical pathway. It features a timeline from the start of the pathway to the estimated discharge date. This screen is also used for documentation and prescription of elements specific to each phase. The physician can use the graphical timeline to check his patient's progression along the different phases and confront it with what was initially projected. He has to fill structured progress notes that will be used to determine when the patient is ready to progress to the next phase. Should the patient's condition be incompatible with graduation, as would be the case if a worsening dyspnea is documented in this scenario, red flags would appear on screen to alert that the patient deviates from its ideal clinical course. This should prompt a more timely response from the clinician to address and hopefully correct the situation.
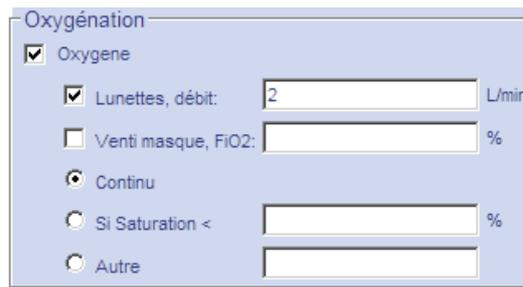

Figure 2. Order sets for a phase of the clinical pathway

Figure 2 illustrates orders specific to the management of one phase. Those order sets can include a subset, or the entirety, of the required prescriptions in this clinical setting, but physicians never lose their ability to override or tweak the proposed orders.

5. Conclusion

Standardized clinical pathways have been shown to improve many indicators of efficiency in patient care. They facilitate planning, optimize quality, minimize costs and lead to improved patient safety [8, 9]. Development and implementation of pathways is a challenging task for the various partners involved, such as doctors, nurses, patients and hospital managers, as it brings concepts of standardization and planning that have not been historically part of healthcare's landscape. Furthermore, successful translation of the theoretical vision of a process of care into an operational model, with detailed description of expected results and actions to undertake, is very difficult and requires frequent questioning of things we tend to take for granted.

Implementing pathways on a computer information system is also a very challenging task. It involves dealing with abstract concepts that require structuring. It must take into consideration various human, medical, technical and logistic factors. Having a CIS whose wide array of functionalities can be accessed and driven from a workflow engine is a critical requirement, and something that is not a feature of most commercial offerings. In addition, the CPOE, which is at the core of such a system, must be able to deal with the various types of actions involved in the care of the patient, from admission to discharge, in a centralized and integrated care plan.

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