Clinical Information Systems —What Is the Bottom Line?

Introduction of a nontrivial clinical information system (CIS) generates major cultural challenges.[1] The most obvious relate to the need for health care workers to acquire new skills and do their work in new ways. More subtle challenges relate to alteration of roles and workflow throughout an institution. Implementation of a CIS often undoes myriad "fixes" that were applied over time to make the predecessor manual "nonsystem" processes work better.

In this issue of the Journal, Murray et al.[2] document shifts in pharmacists' functions caused by the implementation of a computer-based outpatient physician-to-pharmacy prescription system. They show that, for the institution involved, there was no significant improvement in the mechanical efficiency of the pharmacy workflow. Pharmacists spent as much time clarifying the orders that came to them electronically as they previously did entering prescriptions directly. This finding makes clear that the CIS was not designed to shift data entry to the care provider from the clerks and ancillaries. The motivation for implementing an integrated, cross-functional CIS was, and should be, to improve the quality and overall efficiency of patient care. Such systems can be successful when the institution works "smarter," though not necessarily "faster."

The key goals for CIS include capture of information, preferably once from the most reliable source; delivery of "just-in-time" decision support; and the augmentation and refinement—not the translation—of information as it moves from one area of institutional or clinical expertise to another. Proper design of a computer-based physician prescription-writing system requires clarification of distinct roles for each person who participates in the process. The physician selects the best therapy for the patient and records clinically significant information including the patient ID; the substance(s) to be administered; the dosage, route, and duration; a sense of how urgently the medication must be started; and, optionally, diagnoses or reasons for treatment. Next, the pharmacist augments and refines this clinical information with specific dispensing information including the formulation of the substance (e.g., manufacturer and tablet size), administration times (e.g., the "routine" time for a given inpatient ward or shift), and clerical instructions. Nurses or patients who administer the medication then document the times of administration and report any adverse effects or skipped doses. It is the shared responsibility of the persons selecting the therapy, dispensing it, and administering it to determine whether there are potentially significant drug interactions or allergies that merit consideration of an alternative therapy. Each step represents a different perspective, exemplified by a different set of constraints and business rules.

Knowledge bases owned by any participant in the process should be shared in order to move decision support closer to its logical point of use. For example, most hospital pharmacies use, maintain, and customize computer-based systems to check the dosage of drugs and to assist in the detection of drug allergies and drug–drug interactions. The pharmacists have the expertise necessary to maintain this knowledge, but if its use can be moved to the decision-maker at the time of entry of orders by physicians, errors can be prevented before decisions are made final, before they reach the pharmacy. Such strategies can improve mechanical efficiency as well as quality. Similarly, care providers should be responsible for maintaining the list of allergies, as they obtain this information directly from their patients. This list should be available to pharmacists to assist in their review of the treatment plan. In this way participants each do their part to ensure that the other members of the treatment team have the best information on which to base decisions.

Realistically, however, both technical and cultural challenges impose compromises during actual implementation. The profound alteration of work flow makes it difficult to fully specify a priori the overall data model or to formalize and externalize business rules. Iterative refinements are necessary. Often, free-text entry is allowed despite its technical inconvenience, in order to provide the expressiveness and ease-of-use required to gain acceptance from clinical users. Such compromises, which are, in essence, temporary, may contribute to the lack of mechanical efficiency observed in the study by Murray et al.

When designing, implementing, and evaluating a complex CIS, it is important to acknowledge the necessity of cultural changes, some of which can be anticipated and some of which cannot. Prototyping systems with end-user input, analyzing early and

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intensely the impact of a new "live" system on people and work flow (informally or more formally, as was done by Murray et al.), and evolving the system rapidly after initial implementation to continually improve work flow and end-user satisfaction are essential components of "clinical informatics." It is often necessary to implement temporary placeholder algorithms that provide function without compromising the ability to evolve toward a reference architecture.

It is crucial to remember that the primary goal of a CIS is to improve the delivery of patient care. The article by Shojania et al. in this issue[3] documents the ability of an order entry system to improve compliance with vancomycin prescription guidelines. That work, along with the work of Murray et al., provides an example of why institutions should implement systems that improve clinical decisions at the point of care.—ANTOINE GEISSBUHLER

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