Inpatient Computerized Provider Order Entry (CPOE)

Findings from the AHRQ Health IT Portfolio

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Background

The safe use of medications is an important area of concern within health care. In an average week in the United States, four out of every five adults will use prescription medications, over-the-counter drugs, or dietary supplements of some sort; nearly a third of adults will take five or more medications.[1] These medications usually provide some benefits to the person taking them, or at least do not cause harm. Yet medications occasionally cause injury. Process-related medication errors and adverse drug events (ADEs) are still too common, often preventable, costly, and they can result in serious injury or death.[2-4]

To reduce the occurrence of medication-related errors, the Institute of Medicine recommends implementing health information technologies in conjunction with other process improvements.[5] Computerized provider order entry (CPOE) is a health information technology (health IT) system that is commonly used by hospitals and other health care providers to prevent medication-related errors and increase efficiency in medication administration.

This report describes the experiences of AHRQ grantees who have implemented inpatient CPOE systems. Content was derived from phone interviews conducted with key members of selected grantee implementation and demonstration project teams in terms of identified challenges, facilitating factors, and lessons learned regarding inpatient CPOE implementation and use.

What Is CPOE?

CPOE is an application that enables providers to enter medical orders into a computer system that is located within an inpatient or ambulatory setting. CPOE replaces more traditional methods of placing medication orders, including written (paper prescriptions), verbal (in person or via telephone), and fax. Most CPOE systems allow providers to electronically specify medication orders as well as laboratory, admission, radiology, referral, and procedure orders.

On its own, CPOE has an impact on safety by ensuring that orders are legible. Yet the value of this functionality is increased by adding clinical decision support (CDS) systems.[6-7] CDS is a technology that provides clinicians with real-time feedback about a wide-range of diagnostic and treatment-related information as they are entering electronic orders. By running electronic rules in the background, decision support can check for a variety of potential errors. Examples include drug interactions, patient allergies to prescribed medications, medication contraindications, and renal- and weight-based dosing.

When implemented together, CPOE systems and CDS can improve medication safety[8-11] and quality of care[12-15] and reduce costs of care.[16] They can also improve compliance with provider guidelines,[17-18] as well as the efficiency of hospital workflow.[19-20] Most evidence demonstrating the value of CPOE comes from research in hospital settings.

Despite its advantages, less than 5 percent of U.S. hospitals have fully implemented CPOE.[21] A survey of community hospital physicians found that, even in hospitals that have adopted CPOE, less than half of physicians entered at least 80 percent of their orders electronically.[22] The Leapfrog Group estimates that it will take more than 20 years for CPOE to achieve "maximum penetration" within urban hospitals.[23]

Scope

Between 2004 and 2005, the Agency for Healthcare Research and Quality (AHRQ) awarded over $166 million in funding for health IT. The AHRQ health IT portfolio consists of grants and contracts that have planned, implemented, and evaluated the impact of various information technologies on the quality, safety, and efficiency of health care delivery. This report focuses on a sample of ten grants from the Transforming Healthcare Quality through Information Technology (THQIT) initiative that supported implementation or evaluation of inpatient CPOE to improve care for patients, increase efficiency, and contain costs. For the purposes of this report, we have defined "inpatient CPOE" as CPOE systems that are implemented in hospital settings and are used in the care of inpatients.

Our analysis of the grants presents a snapshot of their activities, mostly as they are completing their implementation cycles. The scope of our analysis was limited to challenges

that grantees faced during development, implementation, or evaluation of a health IT intervention. Evaluation of the projects' final outcomes was not part of this analysis in part because results were not yet uniformly available when this report was being drafted. AHRQ encourages individual grants to disseminate final outcomes through peer-reviewed journals, trade publications, and other dissemination vehicles.

To identify THQIT projects that were implementing CPOE interventions in hospital settings through the THQIT mechanism, we reviewed each grant's original application. A convenience sample of nine urban/rural and geographically disparate groups of projects whose leadership was available to participate was selected for inclusion in this analysis. The National Resource Center (NRC) interviews with lead investigators were the primary source of information for this report.

Prior to conducting semistructured interviews, we developed questions and shared them with all of the lead investigators via email. This process enabled the NRC to collect from investigators candid accounts of their core project design elements, key challenges, lessons learned, and future directions for inpatient CPOE use within their respective hospitals. These pragmatic stories are presented below.

Profile of the AHRQ Health IT Portfolio

Grantee Characteristics

This subset of the AHRQ grantees and contractors who have implemented or are in the process of implementing inpatient CPOE come from geographically diverse areas in the United States, with three coming from urban areas and six from rural areas (Table 1).

The fact that the majority of THQIT grantees implementing inpatient CPOE are from rural settings and are using commercial CPOE systems is important to note, since predecessor CPOE implementation efforts have primarily occurred in large, academic medical centers with internal technology development teams.[24] Little evidence exists on CPOE systems that have been developed by commercial vendors or implemented in rural settings. The THQIT initiative was structured to address these poorly understood implementation factors. Each

inpatient CPOE project in the AHRQ portfolio has implemented a commercial system, which will allow evidence on outcomes from a variety of commercial systems to be gathered in the future. The focus of this analysis is on best practices observed during the implementation of a commercial CPOE system, however, and not on reported evidence of clinical or financial outcomes.

TABLE 1: CHARACTERISTICS OF PROFILED PROJECTS

Grant	Region	Rural/ Urban Projects
CCHS-East Huron Hospital CPOE Project	Midwest	Urban
CPOE Implementation in ICUs	Midwest	Urban
Comprehensive IT Solution for Quality and Patient Safety	South	Urban
Implementing an Ambulatory Electronic Medical Record and Improving Shared Access	Midwest	Rural
Improving Health Care through HIT	Midwest	Rural
Medication Management: A Closed Computerized Loop	Northwest	Rural
Project InfoCare	Midwest	Rural
Regional Approach for THQIT in Rural Settings	Northeast	Rural
Rural Iowa Redesign of Care Delivery with Electronic Health Record (EHR) Functions	Midwest	Rural

Technologies

CPOE was not the only technology implemented or evaluated among these nine THQIT projects. Many projects implemented an electronic medical record (EMR) system at the same time, and others extended their existing EMR systems by adding a CPOE component. Some of the projects implemented bar-coded medication administration (BCMA) technology in conjunction with CPOE. Each CPOE system employed a CDS element to

provide clinicians with access to evidence-based guidelines, prompts, and alerts at the bedside. These projects indicate that the use of CPOE should not be pursued in isolation from other technologies; that is, simply entering orders in a system without providing clinical decision support during the order-entry process may have limited benefit. In order to optimize impact on quality, safety, and efficiency, CPOE should be an integrated component of the health IT system.

Findings

The interviews provided rich detail about grantees' successes, failures, and lessons learned. Major themes from the interviews are discussed below and include staffing, resource allocation, clinical steering committees, project scope, workflow, order set design, vendor relations, interoperability, customization and system integration, demonstration systems, training, technical support, and alert fatigue.

Training

Continuous, frequent training and retraining are critical to the success of inpatient CPOE initiatives; this can be difficult for small and rural facilities. For example, one project did not have any full time physicians on staff, so providers used CPOE infrequently while they were taking inpatient calls. Because clinicians did not retain the skills needed to use the software, frequent retraining was necessary. Another grantee at a large, integrated delivery network, reported that approximately 3,000 hours of provider training were logged by training staff over the course of 18 months in preparation for CPOE "go live." At the same institution, about 10,000 hours of training for about 800 individuals including nursing, ancillary services, and other staff occurred over the same period.

Making a demonstration system available to potential users for testing prior to "go live" can help to identify implementation issues and training needs. Several grantees created demonstration systems that allowed clinicians to interact with systems that were physically separate from the planned production system.

Such a preproduction environment enabled many projects to employ "just-in-time" training before "go live." Because they were located outside of clinical areas, typically in a doctor's lounge, clinicians could use the demonstration systems without interrupting existing workflows. Typically, superusers or implementation team members visited the areas in which the clinicians were using the demonstration systems. Clinicians could ask questions of the implementation team, often in a one-on-one environment. This approach put clinicians at ease with computer training, and it was often more efficient for implementation team members. Demonstration systems also were useful to grantees for ongoing training after "go live." They consisted of live systems with hypothetical data.

Staffing

Qualified personnel who understand both clinical and IT domains improve the chances of success when planning for, implementing, and evaluating health IT. Ideally, such personnel should be involved from the start of the planning process. Yet several AHRQ project directors indicated that personnel who have both clinical and IT expertise are scarce, especially in rural areas. Urban medical centers also have reported difficulty in locating and retaining health IT staff because they are unable to offer salaries that are competitive with those offered by the corporate sector. (Of note, the Bureau of Labor Statistics' latest report (2007) shows that 18 of the 20 fastest growing occupations between 2004 and 2014 will be in the health care and computer science fields.) [25]

Several approaches for securing and using qualified personnel were described by AHRQ investigators. One project hired 2.5 FTEs to support a hospital-wide CPOE implementation. These clinical staff members were responsible for managing day-to-day details, developing clinical order sets, and providing support to the clinical staff before and after "go live." Faced with a lack of local health IT expertise, another project hired an outside consultant. A third project trained existing, internal clinical and IT staff during the planning phase. All three strategies were found to be helpful in addressing the challenge of identifying qualified staffing for health IT projects.

Workflow

Understanding workflows and redesigning inefficient processes are critical steps to ensuring successful adoption of CPOE. CPOE is a disruptive technology that fundamentally changes the processes used to place, review, authorize, and carry out orders. Researchers and practitioners have written extensively about the importance of workflow redesign when implementing CPOE.[6] Grantees heeded the advice in this body of literature, and they invested heavily in process redesign when planning for their CPOE implementations.

Before selecting a CPOE solution, there is no substitute for conducting a needs assessment and gathering requirements to determine product and workflow needs. CPOE efforts should not be initiated in a "product selection" mode. Rather, CPOE should be viewed as a solution to a recurring patient safety problem.

Projects mapped existing processes to "future state" ones to better understand the impact of changes on their systems. Although they required a significant investment of time during the early stages of planning, process redesign efforts enabled projects to identify and correct weaknesses in existing information processes. This enabled them to integrate electronic ordering effectively into their clinical workflow. Decisionmakers in the redesign process included "on-the-ground" clinicians, clinical managers, organization executives, and other staff.

Some grantees used manual techniques (e.g., pencil and paper) to diagram their workflows. Others used mapping software (e.g., Microsoft® Visio®) to outline existing processes and recommended changes. Mapping software can help end users and project implementation teams to visually represent workflow needs during system design and training. Diagramming the full cycle of how an order is tracked through a system, from inception to completion and notification, is critical to showing how existing and redesigned processes impact system performance.

For instance, grantees indicated that the use of a CPOE system significantly impacted the workflow of unit clerks, a finding that must be considered in the redesign process. When using a paper-based system, unit clerks are able to track and manage the ordering process. For example, a unit clerk may be able to intercept a duplicate, paper-based test order. In an electronic order environment, the unit clerk may not be able to review orders before they are delivered to their recipient (e.g., the laboratory). This has the potential to impact negatively the workflow of other hospital departments.

Several grantees emphasized the need for CPOE implementation to involve representatives from many areas of hospital operations in discussions of how CPOE implementation will affect their department's workflow and its interaction with other departments or units. Implementers should recognize that some tasks will be reassigned to different personnel, others will be eliminated, and some new tasks will be added. Another lesson from grantees is that it is important to avoid automating an inefficient manual process from the paper world.

Resource Allocation

Organizations must allocate resources and time for CPOE implementation. Identifying adequate resources (both financial and human) for health IT planning, implementation, and maintenance is a challenge for all health care organizations. Particularly for small-to-medium-sized health care organizations, capital expenses for CPOE present a roadblock. Other factors that constrain greater adoption of CPOE systems include shrinking organizational budgets and competing IT projects. Funding from AHRQ provided grantees with some, but not all, of the capital they needed to secure and implement a CPOE system. The AHRQ projects were required to utilize other funding sources, including payers, State-based loan programs, and organizational IT budgets to finance their systems. To identify such funding, hospital administrators, boards of directors, and other key stakeholders engaged in strategic planning and demonstrated strong commitment to implementing CPOE.

To use CPOE to improve the health care delivery process, it is necessary for implementers (e.g., clinicians, hospital staff, and administrators) to devote part of their job to workflow redesign, order set development, and other implementation activities. In order to address these new responsibilities some adjustments in remuneration or responsibilities may be necessary. Compensating clinical staff for their time to support CPOE implementation efforts may be critical to the success of CPOE. In general, clinicians cannot afford to engage in hours of "volunteer" CPOE implementation activities, since it could result in a loss of time devoted to normal clinical duties.

Hospitals must find a way to compensate clinicians for the time they spend on preparation for and implementation of CPOE. This is especially true for clinicians who become "superusers"—users who spend additional time learning how to use the system, assisting the implementation team, and keeping their colleagues informed about the implementation process.

Working With Vendors

Grantees emphasized the importance of establishing and maintaining good relationships with CPOE vendors throughout the implementation lifecycle. Delays in project planning

and implementation are common. Implementation delays reported by the grantees varied, ranging from 6 to 18 months. Frequently, project delays are due to delays in product delivery, updates, and integration.

For example, during the planning process the vendor may advocate that the hospital delay implementation by 6 months in anticipation of a new version of the product. Grantees reported that waiting for the future version often involved more time than originally estimated by the vendor. In addition, grantees found that software updates delivered in the middle of the implementation process can be time-consuming to install and test. It is often the case that updates interfere with previously well-functioning systems. Grantees said maintaining a good relationship with the vendor during project challenges can help to facilitate faster and more efficient resolution of issues.

Because of the frequency of the delays, grantees recommended that hospitals include delay and negligence penalties when negotiating contracts. Contracts also should include provisions for receiving updated content and software releases at no additional cost for a specified amount of time, such as during implementation or up to 6 months after "go live." Grantees further recommended that hospitals try to create economies of scale when negotiating contracts.

AHRQ grantees found that when smaller organizations banded together, they were able to negotiate financial discounts on products and services. Community alliances may involve other hospitals, physician practices, and area clinics. One AHRQ grant involved an independent, not-for-profit organization that had been formed to serve ten critical access hospitals in a region. Large groups and entities not only have the opportunity to negotiate discounts, but also can influence the functionality of the product in the future and create a user community to help facilitate long-term improvements in a product.

Clinical Steering Committies

Many grantees used "clinical steering committees" to organize, lead, and resolve problems related to planning and implementation. One advantage of such committees is that they provide a neutral ground for making key decisions. Members of such committees included

physicians, nurses, and executives such as the Chief Medical Information Officer (CMIO) and/or the Chief Nursing Officer (CNO). Clinical steering committees helped work to achieve CPOE goals, resolve issues quickly, and serve as "clinical champions" for their peers. The steering committees usually consisted of volunteers and involved significant time commitments from participating clinicians.

Grantees indicated that it is important to form steering committees early in the CPOE implementation planning process and to maintain them throughout all phases of the CPOE system "life span." Even after implementation, clinical steering committees can address issues that arise during later phases of the CPOE project.

Consideration of Changes in Scope

During implementation, careful consideration of the benefits and potential impact of available feature requirements or changes in scope is necessary. The health IT field is rapidly changing, and there can be a tendency to delay CPOE implementation to incorporate the "latest-and-greatest" system that will soon become available. As stakeholders gain a more comprehensive understanding of CPOE capabilities, it is common for users to be tempted to modify or increase user requirements. This change usually results in additional delays and costs that must be considered and prioritized by the project team.

Grantees recommended that projects adhere to the original requirements and scope for the contracted vendor system and institute a process to evaluate additional organizational needs and changes in scope. They indicated that projects should be wary of "scope creep" and feature enhancements that may not be critical to the initial rollout of the CPOE project.

The potential impact of changes in scope during implementation underscores the importance of addressing a comprehensive requirements development process during the vendor scoping and contracting process. If custom vendor development is needed, or the needed capability is in a future product release, the implementation timing and cost may be affected.

Order Sets

A CPOE system requires that hundreds of orders and order sets be configured. This is a cumbersome process that requires the participation of numerous and disparate clinical departments in a hospital. Each of the nine grantees featured in this document started their order set development process by using a standard, baseline collection format provided by a vendor. Some grantees received this functionality from their CPOE vendor directly, while others purchased it from a different vendor specializing in the delivery of order sets. The grantees emphasized that, although they began with a baseline collection tool, the order set development process was time consuming. They typically required between 6 and 8 months to customize the baseline collection in order to meet the needs and expectations of the hospitals and clinicians.

Although time consuming, the process of developing and customizing order sets can have a positive impact on overall CPOE implementation. Because it requires input from clinicians in a wide range of units and departments, order set development can help to engage clinicians in CPOE implementation. Several grantees reported that their order set development processes were primarily managed by clinical oversight committees or councils, but that other clinicians were encouraged and welcome to pose a question or make a comment through department meetings and open committee meetings. Grantees further asserted that clinician involvement in the development of order sets led clinicians to feel that they had a stake in the success of the changes. The involvement of a wide range of clinicians (e.g., physicians, nurses, respiratory therapists) paved the way for higher rates of CPOE adoption after implementation.

Grantees further recommended that hospitals carefully design how clinicians activate order sets. A strong advantage for using order sets is that they minimize time required for clinicians to order routine and guideline-driven tests and medications. Default values for orders can dramatically reduce the time needed to order a test or medication. For example, they can automatically complete certain data fields, such as dosage, length of treatment, and testing interval. However, one grantee found that clinicians viewed default values as "recommended values," and were offended by the CPOE system's "suggestions" for how they should practice medicine. Yet, other grantees warned that systems with too many free

text fields (e.g., blank fields that allow the clinician to type unstructured narrative) provide opportunities for error, and can result in confusion among the lab technicians and pharmacists who receive completed orders.

Interoperability

Effective CPOE implementation requires integration with existing hospital information systems such as registration, pharmacy, laboratory, and electronic medical record systems. All of the grantees experienced challenges in connecting CPOE to other internal hospital systems.

One project found that, even though it had purchased its inpatient and ambulatory CPOE systems from the same vendor, integrating the data produced by each system was difficult. Another project reported that its vendor was unwilling to build a bridge between the CPOE system and the hospital's existing electronic health record (EHR) system, which had been purchased from a different vendor. Frustrated, the project eventually abandoned the first vendor's system in favor of one from a vendor that was willing to "play ball" with the hospital's EHR system vendor.

Technical Support

Ready and immediate access to technical support is critical to the success of CPOE. Organizations can expect that users will have many concerns and questions about CPOE during and after implementation. Because of the nature of inpatient care, questions regarding CPOE may occur at any time of the day or night. Therefore, organizations need to have access to technical support resources 24 hours a day, 7 days a week. This level of support should be factored into the training process and the development and planning for internal technical support resources.

During initial implementation, which can last several months, many projects staffed around-the-clock experienced superusers, technical resources, and vendor resources on the floors and within a "command center" nearby. Rapid capture and support for issues during "go live" facilitates quick resolution and can help drive end user adoption.

One grantee provided four ways to enter issues and offer support during the initial "go live" period: (1) via an intranet portal, (2) by making help desk staff accessible by email, (3) by staffing a command center to offer support and technical resources for the first 3 weeks of "go live," and (4) by offering 24-hour shadowing support for the first 6 weeks of "go live." This grantee also instituted a rapid response team for the first few days of "go live" to identify and resolve workflows or order sets that were confusing or unclear to providers. By resolving issues immediately, the project was able to limit end users' tendency to use workarounds that might adversely affect workflow or safety. Finally, this project reinforced optimal workflows by sending daily updates to providers with helpful hints and monitoring provider ordering patterns with real-time order tracking.

Alert Fatigue

"Alert fatigue," commonly experienced after a CPOE goes live, is caused by a combination of critical medical alerts and a high volume of marginally medically consequential alerts. Alerts are also triggered when patients with multiple diseases (comorbidities) are taking several drugs that may interact with one another. Alert fatigue can lower adoption among physicians due to physician annoyance with the superfluous pop-ups and warnings for common interactions that cause little to no harm to patients. Redundant alerts also can reduce clinicians' sensitivity to the alerts, increasing the opportunity for patient safety error.

One way to minimize alert fatigue is to turn off alerts when risks are minimal. For example, a grantee reported that its behavioral health department turned off alerts for antianxiety drug interactions with common over-the-counter sleep aids, since the providers were fully aware of the minimal risks these combinations pose. Another grantee assigned a staff member to round with providers so that complaints about alerts could be identified promptly. Complaints were shared with a clinical oversight committee that had the authority to turn off minimal risk alerts.

Drug-allergy alerts that are triggered by a low threshold for defining a clinically meaningful adverse reaction can result in extraneous alerts being activated. One grantee discovered that multiple drug-allergy alerts were being dismissed quickly by the providers. When asked, the providers raised concerns regarding how allergies were being associated with patients. Some

providers felt that a minor adverse reaction to a medication, such as nausea or a headache, did not mean the patient was allergic to that medication. The hospital worked to answer the question, "What is an allergy?" and revised how patient allergies were entered into the EHR and CPOE systems. The hospital also revised its processes for capturing and recording patient allergies. Drug-allergy alerts were revised, resulting in a lower number and severity of alerts. Clinicians viewed the dialogue and discussions around the drug-allergy alerts as a positive process for their medical community.

Conclusion

With time, it has become clear that the task of implementing health IT presents multiple challenges. This may be particularly true of implementation of CPOE, which has clinical decision support functionality. The AHRQ grantees interviewed for this project have encountered and mitigated a number of challenging issues associated with the implementation and use of inpatient CPOE. Their experiences and lessons learned emphasize the need for strong leadership, a solid implementation approach, good relationships with vendors, strong training and technical support programs, and an approach to adoption that incorporates the lessons of the past. By sharing these lessons, AHRQ hopes to help those who are headed down the path of implementing CPOE to anticipate challenges and mitigate workarounds.

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