

1 **Draft ASHP Guidelines on Pharmacy Planning for Implementation of**  
2 **Computerized Provider Order Entry Systems in Hospitals and Health**  
3 **Systems\***  
4

5 **Purpose and Scope**

6 The purpose of these guidelines is to provide guidance to pharmacists in  
7 hospitals and health systems on planning for and implementing safe  
8 computerized provider order entry (CPOE) systems. To date, most CPOE  
9 guidelines have concentrated on the functionality required of a CPOE system,  
10 despite the fact that most CPOE system implementations occur using  
11 commercial systems whose functionality is largely pre-determined. These  
12 guidelines are intended to help pharmacy directors, managers, informaticists,  
13 and project managers successfully engage in this type of CPOE system  
14 implementation. This document, the first part of a planned series of ASHP  
15 guidelines on CPOE, addresses the planning phase of CPOE implementation.

16 Topics covered in these guidelines include:

- 17 • developing a multidisciplinary planning and implementation team;
- 18 • defining the vision, goals, and objectives of the CPOE system;
- 19 • establishing essential metrics to measure the success of CPOE system  
20 implementation;
- 21 • re-engineering the medication use process as part of CPOE system  
22 implementation;

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- 1 • planning for scope and depth of clinical decision support (CDS);
- 2 • determining the functionality that ensures the safety of the CPOE system;
- 3 and
- 4 • educating and training healthcare providers to use the CPOE system.

5 The recommendations presented in these guidelines can be used for strategic  
6 planning with the organization's decision makers, drafting contract provisions,  
7 prospectively comparing CPOE systems, and creating an implementation plan.

8 These guidelines should be used in conjunction with other literature on the topic  
9 and information from prospective or selected CPOE vendors. Pharmacists should  
10 exercise professional judgment in assessing their health system's needs  
11 regarding CPOE systems and in adapting these guidelines to meet those needs.

12

### 13 **CPOE and the Electronic Health Record**

14 In its 1999 report *To Err is Human*,<sup>1</sup> the Institute of Medicine (IOM) shocked the  
15 nation with its estimate of deaths due to medical error. Two large studies, one  
16 conducted in New York<sup>2,3</sup> and the other in Utah and Colorado,<sup>4</sup> revealed adverse  
17 events occurring in 2.9% and 3.7% of hospitalizations, respectively. Over half of  
18 these adverse events were judged to be preventable. Based on these studies,  
19 the IOM estimated that 44,000 to 98,000 Americans die each year due to medical  
20 errors in hospitals.<sup>1</sup> Many of these deaths are caused by medication errors or  
21 preventable adverse drug events (ADEs).<sup>5,6</sup>

22 When it was recognized that errors resulting in preventable ADEs involved  
23 a wide range of drug classes and most commonly occurred at the prescribing

1 stage,<sup>7</sup> interest in CPOE systems grew. In a second report, *Crossing the Quality*  
2 *Chasm: A New Health System for the 21st Century*,<sup>8</sup> the IOM called for  
3 information technology (IT), including CPOE, to take a central role in the redesign  
4 of the health care system to improve quality, increase efficiency, and reduce  
5 errors. In addition to the IOM, organizations such as the Leapfrog Group and the  
6 the National Quality Forum have pushed for hospitals to adopt CPOE.<sup>9,10</sup>

7         In contrast to target drug use evaluations, CPOE has the potential to affect  
8 the ordering of all medications. Even a basic CPOE system can eliminate illegible  
9 and incomplete orders and facilitate an efficient order processing through  
10 instantaneous transmission of orders to hospital departments such as pharmacy  
11 and laboratory. Additionally, if the CPOE system is interfaced with the pharmacy  
12 system and the nursing medication administration record (MAR), transcription of  
13 medication orders can be completely eliminated, resulting in another potential 6%  
14 decrease in ADEs.<sup>7</sup> A homegrown CPOE system has been shown to decrease  
15 medication errors by 55% to 80%.<sup>11,12</sup> There are many reports of improvements  
16 in physician practices and patient outcomes with health IT related to ordering,<sup>13-20</sup>  
17 but in some reports it is difficult to distinguish whether the benefits were due to  
18 the electronic health record (EHR), CPOE, CDS, or a combination of all three.  
19 The synergy of the three of these will likely lead to the most significant  
20 improvements.<sup>14,15</sup> And although there are many reported benefits to CPOE,  
21 there is a growing body of research pointing to new problems introduced by  
22 CPOE, including e-iatrogenesis.<sup>21</sup> Though the systems themselves may  
23 contribute to these problems, design and implementation decisions play a role in

1 the avoidance of these new errors.

2         More recently, attention has focused on the development of an integrated  
3 information system to support the coordination and integration of clinical and  
4 business processes. The terminology for such information systems is evolving,  
5 with "enterprise information system" sometimes used to describe the broader  
6 system that integrates clinical and business systems, and the EHR used to  
7 describe the clinical information system, which may include a patient portal or the  
8 ability to link to a personal health record (PHR).<sup>22</sup> CPOE must be viewed in the  
9 context of the EHR, which would integrate CPOE, CDS, departmental information  
10 systems and make patient-specific clinical information available to the providers.

11         The EHR is a longitudinal electronic record of patient health information  
12 generated by one or more encounters in any care delivery setting.<sup>23</sup> It contains  
13 medical histories, medication lists, laboratory results, diagnostic images, clinical  
14 documentation, progress notes, narrative summaries (such as operative reports  
15 or consultations), and other information related to patient encounters.

16 Digitalization allows broad clinician access to patient-specific clinical information  
17 in the EHR, which is vital for improvement in clinical quality and patient safety.

18 When fully deployed within a facility through protected networks, the EHR serves  
19 as an information source as well as a platform to coordinate patient care and  
20 communicate with the health care team. In addition, codified data can be used to  
21 trigger effective decision support as well as to provide for data acquisition for  
22 continuous quality improvement.

23         For CPOE to be most useful it must be deployed as part of an EHR and

1 not as a stand-alone module. CPOE is the process of health care providers  
2 entering orders and related information directly into the EHR. It places the  
3 provider at the center of patient care, allowing direct access and secure sharing  
4 of health information. The advantages of a complete EHR include the ability to  
5 integrate patient-specific information (e.g., laboratory results, weight) crucial for  
6 CDS, as well as a minimal need to interface information from one system to  
7 another. Most importantly, the EHR provides “one-stop shopping” for health care  
8 providers. If clinicians are accessing the EHR for all core information and are  
9 already logged onto the system, it is relatively easy to modify the record  
10 electronically by adding or modifying orders. Requiring clinicians to access a  
11 paper medical record for some information – while entering orders electronically  
12 – creates workflow barriers that will inhibit acceptance of the CPOE system.

13         The EHR, including electronic physician and nursing documentation with  
14 CPOE and CDS, are all important pieces of the complex effort needed to improve  
15 hospital care.<sup>14,15</sup> The integration of CPOE and CDS within an EHR can create a  
16 platform to build upon and improve the delivery of health care today and in the  
17 future. Many organizations implement these in a stepwise fashion because of the  
18 enormous work effort and the significant workflow changes required. Although  
19 there is no single solution that fits every circumstance, the literature offers many  
20 examples for others to follow and avoid.<sup>24-27</sup> Regardless of the vendor,  
21 organization size, or other factors that could potentially affect success, there are  
22 quite a number of implementation decisions that can increase likelihood of a  
23 clinician-accepted CPOE installation that leads to quality and safety

1 improvements.

2

### 3 **Planning for Transition to CPOE**

4 A successful CPOE implementation starts with a well-organized, realistic plan. In  
5 planning for the transition to CPOE, initial tasks include assembling a  
6 multidisciplinary planning and implementation team; developing a vision, goals,  
7 and objectives for the CPOE system; establishing essential baseline and post-  
8 go-live data; mapping the current medication-use process; describing the desired  
9 medication-use process; and planning for CDS. The enormous change that will  
10 affect every clinician will make it necessary to thread change management  
11 through every step of the transition. Managing and communicating expectations  
12 is important from day one.

13

### 14 **Developing a Multidisciplinary Planning and Implementation Team**

15 The transition to CPOE is an immense cultural change that will affect every  
16 member of the health care team. No individual and no department will be exempt  
17 from the impact of CPOE. Support for the project at the executive level is a  
18 prerequisite. Medical and administrative leadership are instrumental in the  
19 development of a clear vision for CPOE. A multidisciplinary team approach to  
20 planning and implementation is essential for a safe, well-designed, user-friendly,  
21 and successful CPOE system.

22       Physicians must be central players in the decision-making process, as  
23 prescriber acceptance is crucial to CPOE success. Key ancillary departments

1 (such as pharmacy, nursing, laboratory, radiology, admissions, dietary, and  
2 respiratory therapy) must dedicate resources and be involved in the initial effort,  
3 including workflow/process analysis and redesign, system analysis, integration  
4 between ancillary systems, and review of organizational culture.

5       The involvement of pharmacists in the development and implementation of  
6 CPOE is vital for several reasons. Although the number of successful  
7 implementations is increasing on a yearly basis,<sup>28</sup> the complexity of the systems  
8 should not be underestimated. Pharmacists have the benefit of years of  
9 experience with electronic order entry systems. Although pharmacy systems  
10 differ from CPOE systems in significant ways, pharmacists' experience with  
11 human factors issues related to the interaction between human and computer is  
12 invaluable. In addition, the medication order entry aspect of CPOE systems leads  
13 to the most significant increase in patient safety and is likely the most complex  
14 part of the system.<sup>20,29-32</sup> The initial decision to purchase a completely integrated  
15 CPOE system or develop one that can interface with existing electronic systems  
16 (e.g., the pharmacy departmental information system or automated dispensing  
17 devices) is an important one that would benefit from the pharmacist's  
18 perspective.

19       Information systems or IT departments play a critical but supporting role in  
20 the selection, implementation, and maintenance of CPOE systems. Although a  
21 CPOE system cannot be developed and implemented without IT expertise, the  
22 CPOE system is intended to serve the best interests of patients, and clinicians  
23 such as physicians, nurses, and pharmacists are best suited to determine how

1 the CPOE system can serve those interests.

2       **Recommendations for team structure.** The organization should carefully  
3 consider the structure of the multidisciplinary implementation team, which should  
4 include physicians, nurses, pharmacists, IT staff, and staff from all ancillary  
5 departments, such as lab and respiratory therapy. CPOE systems by definition  
6 require ownership by the medical staff. Therefore, prescribers (mainly  
7 physicians) must actively lead its design. Decisions regarding the CPOE system,  
8 including the content, the user interface, and the flow of CDS will be influenced  
9 by the vendor's product, but acceptance will ultimately reside with the medical  
10 staff.

11       The team structure for implementing CPOE must take into account the  
12 interests and expertise of the following types of individuals:

- 13       • *Content experts.* These staff members may be pharmacists, physicians,  
14       nurses, or practitioners of other disciplines who have access to data and  
15       clinical knowledge that can help shape the CPOE system to be most  
16       useful in the local environment.
- 17       • *Technical experts.* These staff members are typically IT professionals who  
18       understand the capabilities of the system, write the code, and test and  
19       troubleshoot problems.
- 20       • *Front-line users.* These staff members are prescribers, mainly physicians,  
21       who care for patients on a regular basis and who will understand the  
22       positive and negative implications of each proposal regarding CPOE.
- 23       • *Nurses.* CPOE's effects on nurses cannot be overstated. The workflow of

1 incoming information completely changes with the implementation of  
2 CPOE. The unit secretary is no longer the gatekeeper and notifier of new  
3 orders. The development of an electronic means of notification of new  
4 orders must be considered and incorporated into the nursing workflow to  
5 enhance patient care.

- 6 • *Workflow analysts.* These staff members are responsible for analyzing the  
7 workflow and its processes, from admission of the patient, to  
8 hospitalization (including transfers, surgeries, and procedures), to  
9 discharge.

10 Representatives from each of these areas of expertise should work together  
11 regularly, in a variety of committees and work group formats. The committee  
12 should be chaired by a physician and report to the hospital's pharmacy and  
13 therapeutics (P&T) committee as well as medical staff and clinical computing  
14 governance-related bodies. The hospital should consider paying the physician  
15 chair a stipend or supporting his or her salary in some other way to offset time  
16 away from patient care.

17 The health system's existing committee structure may be utilized as  
18 oversight authority for CPOE initiatives before, during, and after the system goes  
19 live. However, there is a strong argument to create small work groups consisting  
20 of physicians, administrators, pharmacists, nurses, and IT personnel to make and  
21 approve design decisions and form specific task groups as needed when policy  
22 or process issues arise. Quick and timely action will be required during the  
23 implementation phase to keep the project moving forward on schedule and in an

1 organized and cohesive manner. This multidisciplinary group should refer  
2 matters of policy to existing policy-making committees (e.g., the P&T committee,  
3 executive committee, practice guidelines committee, or leadership council). The  
4 multidisciplinary CPOE committee is not a policymaker, but rather a tool to  
5 provide structure to existing policies. Some organizations may find it necessary  
6 to keep this new formal committee for ongoing oversight of clinical information  
7 systems decisions and CDS oversight.

8         Pharmacists need to provide oversight for the pharmacy pathway  
9 development. Pharmacist involvement should begin in the initial CPOE planning  
10 stages, and it should continue throughout the vendor selection, pilot, go-live, and  
11 ongoing phases of CPOE development and implementation. The pharmacist(s)  
12 that serve on the multidisciplinary team may be physically relocated to whatever  
13 space the multidisciplinary team is allocated. The pharmacist(s) chosen to serve  
14 on the team should be:

- 15         • A team player;
- 16         • Well-respected within and outside of the pharmacy department;
- 17         • A good communicator;
- 18         • Knowledgeable in all facets of the medication-use system;
- 19         • Well-versed in the regulatory and legal requirements of pharmacy;
- 20         • Current on patient safety initiatives and issues, both external and internal  
21             to the health system;
- 22         • Detail-oriented, with sharp analytical skills; and
- 23         • Open to new ideas.

1 Ideally, the team should build the system from documents reviewed and  
2 approved by a multidisciplinary group such as the CPOE steering committee or  
3 the P&T committee. Building in a test environment that mirrors the production  
4 environment is a safe way to protect end-users (prescribers) from a system  
5 failure. Staff members should be prepared to have things fail, even when they  
6 have been reviewed and tested. It is critical to create a mechanism to report  
7 issues quickly, so the implementation team can investigate and solve the  
8 problem. The CPOE group should maintain lists of problems and review those  
9 lists for recurrent issues. Providing feedback and updates to the persons  
10 reporting problems is vital so clinicians know they have been heard and that your  
11 team has either fixed the reported issue or in many cases may be unable to fix it  
12 so have engaged the vendor to address.

13       **Outside consultants.** External consultants are warranted if there are  
14 insufficient resources, lack of on-site knowledge of the vendor's application, or a  
15 desire for a quicker implementation timeline. External consultants should be used  
16 judiciously and should work in conjunction with permanent members of the  
17 implementation team. It is important that the permanent members of the team  
18 know and understand how each item is built by the consultants, as changes in  
19 one part of the system may have intended and unintended downstream effects in  
20 other parts of the system (e.g., CPOE build affects the pharmacy build). It may  
21 be discovered months after consultants leave that something they built needs to  
22 be reversed or changed because it negatively affects a new or updated  
23 functionality build in another part of the system. It is also important that

1 consultants impart knowledge gained during their tenure to the permanent  
2 members of the team. It is detrimental to have this knowledge leave with the  
3 consultant when the contract expires.

4 Consultants add a unique dimension to the team structure in that they  
5 have experienced how other hospitals have solved similar problems, can offer a  
6 variety of solutions based on their experience from other facilities, and have a  
7 network of colleagues they can contact for advice. Consultants are a great  
8 source of information on how other facilities handle the same challenges facing  
9 the institution they currently are contracted with.

10 **Allocating resources.** The resources required to manage the transition to  
11 a CPOE system will vary, based on a host of factors: the size and complexity of  
12 the institution, whether it is an academic or a community setting, types of patients  
13 served, the current IT infrastructure, the scope of the CPOE project, degree of  
14 system integration, and others. There are no general rules about the time,  
15 money, or number of employees required for such a transition, except that the  
16 resources allocated or available never seem to be enough. The uncertainties  
17 inherent in the process should not discourage thorough planning, however.

18 The resources needed should be identified and approved before the  
19 project begins, as they are unlikely to become available after the project is under  
20 way. Unfortunately, planning often focuses on capital expenses, underestimating  
21 the personnel required to build, test, teach, maintain, and improve the system  
22 once in use.<sup>29</sup> Having these resources in place is critical to the success of the  
23 project. Cutting corners in any of these areas affects the quality of the

1 implementation, which can create lasting negative effects throughout the  
2 organization and jeopardize the success of the project. It is important that the  
3 staff dedicated to the CPOE project are allowed to complete the build and testing  
4 of the system without added pressures. The work involved in building and  
5 maintaining a CPOE system is intensive and requires full-time commitment.  
6 Human resources assigned to these tasks must not have concurrent practice  
7 assignments.

8

### 9 **Developing a Vision for the CPOE System**

10 A vision statement helps describe where the organization wants to be after  
11 CPOE implementation and helps define decision-making criteria and the  
12 framework for metrics. It is vital for the CPOE vision to align tightly with the vision  
13 of the organization as a whole. Large-scale projects should include a clear  
14 organizational vision, which might be as simple as increasing patient safety or  
15 improving provider access to information. In addition, the organization may focus  
16 on using the system to increase direct patient interaction. Taking the time to  
17 develop these overarching criteria will focus the team throughout the  
18 implementation process, help the team communicate the reasons for the  
19 necessary change that front-line clinicians will have to make, and will lay the  
20 groundwork for ongoing measurement.

21 CPOE is a vital component of the institution's overall patient safety and IT  
22 development plans. It is important to establish from the beginning that CPOE is a  
23 clinical intervention and not an IT implementation. The implementation team

1 should determine whether there are other issues that may influence CPOE  
2 implementation, such as new buildings or other system changes (e.g., pharmacy,  
3 bar-coding, or MAR systems). The team should review and attempt to anticipate  
4 trends in regulation or best practices (e.g., from the Centers for Medicare and  
5 Medicaid Services, The Joint Commission, the Institute for Safe Medication  
6 Practices, or ASHP) and adopt practices from similar sites that have  
7 implemented CPOE. Finally, it should be remembered that CPOE is only one  
8 element of the hospital's IT infrastructure. Care should be taken to integrate  
9 these disparate systems, with the end result of a complete EHR.

10       A majority of the pharmacy involvement in CPOE development and  
11 implementation will be related to medication use within the system. Pharmacists  
12 often have experience with entering medication orders into a computer system.  
13 This experience can be used to help providers adapt to the changes that come  
14 with CPOE. Infrastructure, integration, and regulatory compliance also play an  
15 important role in the development of a vision for CPOE.

16       Developing a vision for medication orders in a CPOE system can be  
17 divided into three main tasks: defining the goals and objectives for the CPOE  
18 system, mapping the current and desired medication use processes, and  
19 determining CPOE system performance requirements to reach those goals. An  
20 organization's providers, nurses, and pharmacists can team up to prepare this  
21 vision. This might include describing how products should be named for easy  
22 identification or the configuration of special populations of orders. Consideration  
23 should also be given to how medication orders relate to laboratory results,

1 allergies, and other clinical information.

2

### 3 **Defining Goals and Objectives**

4 Implementing CPOE is an immense cultural change that involves every part of an

5 organization. After an overarching vision for the components of the CPOE

6 system has been established, the implementation team should reach out to all

7 areas of the institution to develop and explain the goals and objectives of the

8 CPOE system. Widespread understanding and acceptance of these goals and

9 objectives will enhance development and implementation of the CPOE system.

10 The central goal of a CPOE system should be improving patient safety and

11 quality, but potential process improvements should also be considered.

12 **Patient safety.** Improving the safety of the medication ordering process

13 should always be in the forefront of any design decision, programming

14 modification, or enhancement to CPOE. The analysis of the existing medication

15 use process (see "Mapping the current medication-use process" below) should

16 identify any safety deficiencies that can be corrected with CPOE, as well as

17 strengths of the current processes. The addition of safety features to CPOE will

18 be an ongoing endeavor, as acceptance of the system grows and clinicians

19 realize how the system can improve their practice.

20 CPOE systems also need to be monitored for unwarranted and

21 unexpected safety failures. Unfortunately, CPOE can introduce previously

22 unknown safety failures through user interaction with the system, programming

23 changes, or poor system design.<sup>25</sup> To prevent the introduction of new medication

1 errors, careful analysis, review, and testing needs to be conducted with initial  
2 implementation and subsequent additions, modifications, and enhancements.  
3 Constant surveillance for errors and unanticipated outcomes are an ongoing  
4 necessity.<sup>29</sup> This evaluation can also be used to develop the goals and objectives  
5 for implementation.

6 One impetus behind CPOE is that the deployment of a well-designed  
7 CPOE system with effective CDS will reduce medication errors and ADEs. A  
8 recent systematic review of the effects of CPOE with CDS on medication errors  
9 and ADEs supports the successful use of CPOE in health care facilities.<sup>17</sup> Many  
10 hospitals will implement CPOE to improve patient care, while focusing less on  
11 research that explores its impact. Nevertheless, internal systems for tracking  
12 medication errors and ADEs should be continually used to assess the impact of  
13 CPOE. CPOE could potentially:

- 14 • Reduce some forms of ADEs or medication errors.
- 15 • Qualitatively change some forms of ADEs or medication errors (e.g., an  
16 error of omission may become a wrong-time error).
- 17 • Introduce new types of ADEs or medication errors (e.g., a physician may  
18 select the wrong drug from a list appearing on the computer screen).

19 **Operational goals.** In addition to safety, operational goals might include  
20 such things as decreasing medication dispensing turnaround time, improving  
21 data collection, or increasing communication among health care team members.  
22 With providers directly entering orders with CPOE, the pharmacy department  
23 could potentially direct more pharmacist resources to patient interaction or areas

1 such as pharmacokinetics, anticoagulation monitoring, drug regimen review,  
2 antibiotic streamlining, or intravenous-to-oral (IV-to-PO) conversions. The goals  
3 will be different for every organization, but it is important to establish them during  
4 the planning phase of the project. Transition to CPOE represents a major  
5 paradigm shift for most organizations. The organized, goal-oriented institution will  
6 benefit from creating concise, measurable goals and objectives.<sup>18</sup>

### 8 **Establishing Baseline Data**

9 In conjunction with the analysis of the current medication-use process (described  
10 in more detail in "Mapping the current medication use process" below), the  
11 multidisciplinary team should develop a clear and complete understanding of the  
12 institution's current medication safety data (e.g., medication errors, ADEs) as well  
13 as the resources devoted to the manual medication order system. It is important  
14 to track data for at least 3 months in advance of implementation to assemble  
15 adequate baseline data. These data can then be compared with new data from  
16 the CPOE system at designated intervals. Data should be tracked over time to  
17 assess the impact of the CPOE system. This information can help identify  
18 workflow bottlenecks or discrepancies in the CPOE system, providing  
19 opportunities for improvement. Examples of data that can be identified and  
20 reported are:

- 21 • Positive response to allergy alerts.
- 22 • Positive response to drug interaction alerts.
- 23 • Dose changes as a result of CDS.

- 1       • Drugs withheld due to contraindications identified via CDS.

2

### 3 **Establishing Post-Go-Live Metrics**

4 Implementation metrics can be used to help measure achievement of  
5 organizational goals. Comparing baseline and post-go-live information can  
6 identify which areas have improved or which need further review. Metrics are  
7 quantitative, measurable parameters that may include:

- 8       • Order entry time (the time it takes providers to enter an order)
- 9       • Number of entered orders
- 10      • Missing doses
- 11      • Pharmacist interventions related to order entry errors
- 12      • Changes to scheduled administration times in the system
- 13      • Pharmacy turnaround time
- 14      • Corrections made to original orders
- 15      • Frequency of provider contact (pages for questions or errors on order  
16        entry
- 17      • Documented medication errors

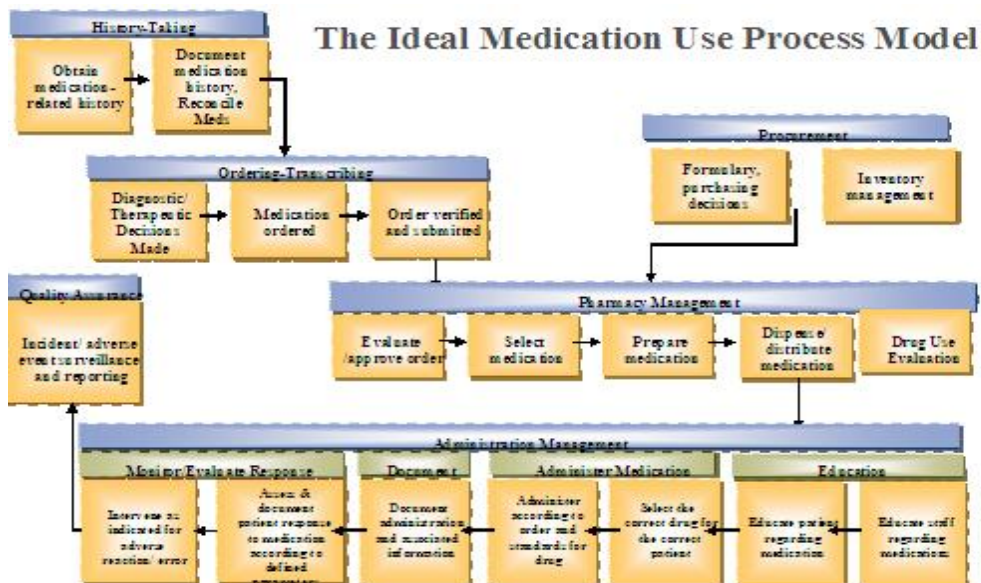
18 When reporting these data, the hospital should be careful not to overstate the  
19 impact of the CPOE system on patient outcomes. The measures listed above are  
20 process measures, not outcome measures. For example, although the CPOE  
21 system may have identified a patient allergy and prevented administration of the  
22 medication, it may be likely that even without the CPOE system the pharmacist  
23 or nurse would have identified the allergy and intervened before the drug was

1 administered.

2 It is also important to identify new errors or ADEs introduced by the CPOE  
 3 system.<sup>24,25</sup> The hospital should actively engage clinicians at all levels in open  
 4 dialogue and reporting of such issues. These reports should be used to make  
 5 rapid changes in the design of the system in the spirit of continuous quality  
 6 improvement.

### 8 Re-engineering the Medication-Use Process

9 The CPOE system should be configured to support the hospital's ideal  
 10 medication-use process; the ideal process should not be compromised to meet  
 11 the artificial constraints of the CPOE system. A description of the ideal  
 12 medication-use process are beyond the scope of these guidelines, but key steps  
 13 in the medication-use process are outlined in Figure 1.



14

15 Figure 1. Medication-use process model. From reference 32. [Permission

16 pending.]

1 A successful CPOE design is a combination of process and technology changes  
 2 that work together to allow the desired improvements to occur. Figures 2-5 list  
 3 some of the process and technology enhancements that have been shown to  
 4 improve medication safety.

5

## 6 **Ordering: Order Writing and Submission**

### **Process Interventions**

- Establish standards for abbreviations
- Establish policies that do not accept incomplete or vague orders such as “continue previous medications”
- Establish standard protocols for drug dosing and administration
- Develop standard order sets to include drug order, associated tests, and associated medicines
- Provide routine staff education on common causes of error
- Educate staff on back-up procedures for system down time
- Establish policies for routine review and updating of current orders
- Monitor the bypass of rules and alerts to complete order
- Do not dispense drug prior to written order or verbal order verification unless critical
- Minimize verbal order use

### **Technology Interventions**

- Implement tools to guide the user:
  - Order entry (CPOE) with standard order sets and protocols
  - Mandatory fields to complete an order
  - Rules-based ordering to include dose adjustment, interaction checking, and accompanying orders
  - Provide formulary selections
- Provide mobile charting devices to allow for ordering at the point of care
- Adequate back-up procedures for system down time
- Updated MAR generated by CPOE or pharmacy system on routine basis (minimum every 24 hours)
- Automated reminders or alerts for changes in patient status
- Automated dispensing units do not dispense drug prior to order verification unless a critical medication

Figure 2. Process and technology interventions in medication ordering that improve medication safety. From reference 32. [Permission pending.]

## Medication History Taking/Medication Reconciliation

### Process Interventions

- Establish procedures for obtaining admission history
- Establish minimum data set to include medications, diagnoses, height, weight, and allergies
- Establish accountability for obtaining minimum data set
- Use standardized templates
- Multi-disciplinary clinical documentation
- Instruct patient/family on need to bring all current medications with them, including over-the-counter medications
- Select and identify “record of truth”
- Establish communication links with primary and extended care providers to support transitions in level of care
- Replace free text with checklists when appropriate
- Establish standard abbreviations for medication recording
- Provide wallet cards or other forms to prompt patients to bring complete home medication information

### Technology Interventions

- Implement tools to guide the user
  - Clinical documentation with templates and checklists
  - Prompts for required fields to include minimum data set
  - Flags to highlight changes in minimum data set from previous data
- Improve access to patient record through implementation of computer-based patient record/clinical data repository
- Establish communication links with primary and extended care providers to support transitions in level of care
- Provide mobile charting devices to allow for documentation at the point of care
- Structured for computer-based clinical documentation
- Technology adherence to standards

Figure 3. Process and technology interventions in medication history-taking and medication reconciliation that improve medication safety. From reference 32.

[Permission pending.]

<b>Pharmacy Evaluation of Orders</b>	
<b>Process Interventions</b>	<b>Technology Interventions</b>
<ul style="list-style-type: none"> <li>– Establish standards for abbreviations</li> <li>– Establish policies that do not accept incomplete or vague orders such as “continue previous medications”</li> <li>– Develop standard order sets to include drug order, associated tests and associated medications</li> <li>– Provide routine staff education on common causes of error</li> <li>– Do not dispense drug prior to order evaluation unless critical</li> <li>– Establish procedures for evaluation of orders and when to clarify</li> <li>– Establish procedures for pharmacy dosing</li> <li>– Develop procedures for escalating an order that is on hold for clarification</li> </ul>	<ul style="list-style-type: none"> <li>– Adequate back-up procedures for system downtime</li> <li>– Minimize system downtime</li> <li>– Automated reminders or alerts for patient changes in status</li> <li>– Pharmacy alerts and reminders based on change in lab value, drug-to-drug interaction, dose-checking, drug-to-diagnosis, drug-to-allergy checking</li> <li>– Targeted alerts that vary by individual receiving them to reduce alert fatigue</li> <li>– Ability to view online clinical information to include: lab values, clinical documentation and orders</li> <li>– Interfaces to auto-populate pharmacy system with ADT, laboratory, clinical documentation</li> <li>– Access to drug knowledge base</li> </ul>

Figure 4. Process and technology interventions in the pharmacy evaluation of medication orders that improve medication safety. From reference 32. [Permission pending.] ADT, admission-discharge-transfer.

<b>Administering Medications</b>	
<b>Process Interventions</b>	<b>Technology Interventions</b>
<ul style="list-style-type: none"> <li>– Standardize medication administration times</li> <li>– Standardize equipment for IV infusion; minimize number of different kinds of devices</li> <li>– Provide tools that assist staff in calculating correct rate of infusion</li> <li>– Stock pre-mixed IV drugs</li> <li>– Establish standard dose packaging and labeling</li> <li>– Patients with multiple IV access lines have line clearly marked at distal end</li> <li>– Distal ports of non-IV tubing incompatible with medication oral syringe</li> <li>– Standard protocols for the physical assessment prior to administering a specific drug throughout the hospital</li> </ul>	<ul style="list-style-type: none"> <li>– MAR with time based schedule</li> <li>– Electronic MAR</li> <li>– Automated drug distribution carts at the point of care</li> <li>– Smart infusion pumps</li> <li>– Alerts to caregiver to obtain and document clinical information prior to administering a drug</li> <li>– Bar code/RFID administration systems</li> <li>– Comprehensive wireless network coverage</li> <li>– Needleless administration system</li> <li>– Other medication delivery technologies</li> </ul>

1 Figure 5. Process and technology interventions in administering medications that  
 2 improve medication safety. From reference 32. [Permission pending.] RFID, radio  
 3 frequency identification.

1 In order to ensure that the integrity, safety, and efficiency of the entire current  
2 medication process is maintained, if not enhanced, it is important to perform a  
3 complete analysis of the current medication-use process and system design. A  
4 failure mode and effects analysis is a useful tool to prospectively evaluate the  
5 potential risks associated with the new process.

6

### 7 **Describing the Current Medication-Use Process and System Design**

8 The analysis of the current medication-use process should consider a variety of  
9 medication order types, based on frequency of use or potential for impact on  
10 patient safety, in all different process settings (e.g., acute care, critical care,  
11 emergency department, procedural areas). Analysts should consider a  
12 representative group of orders that includes the basic types of orders prescribers  
13 typically write and understand how a pharmacist would interpret and dispense  
14 those orders and how the nurse who administers the medication would view the  
15 orders. How the pharmacist enters orders in the current system may not  
16 necessarily be intuitive to a physician. Most importantly, implementers should  
17 consider how the prescriber currently orders these medications on paper and  
18 what would make the most sense to the prescriber when ordering electronically.  
19 CPOE systems should be designed from the prescribers' perspective, with an  
20 eye on the flow of orders throughout their lifetime.

21 Certain medications or groups of medications may need special attention  
22 due to current technology limitations or workflow differences. The types of  
23 medication orders that should be reviewed and included in the design, as well as

1 the processes across which they should be considered, are listed in Figure 6.

2

3 **Medication Order Types**

- Oral solids
- Oral liquids
- Topicals
- High-risk medications (e.g., anticoagulants, heparin, insulin, or potassium chloride)
- Compounded medications, such as triple mix or acetazolamide suspension (e.g., oral swish-and-swallow or dermatological preparations made in the pharmacy)
- Combination products (e.g., hydrocodone-acetaminophen, multi-drug inhalers)
- Respiratory therapy
- Total parenteral nutrition
- IV medications
  - Piggy-back IVs
  - Continuous infusion medications and titrations
- Flushes
- Medical staff protocols that include medications
- Automated dispensing device overrides
- Irrigations
- Immunizations
- Patient-controlled analgesia, including epidural analgesia
- Sliding scale insulin and heparin
- Chemotherapy standard and non-standard protocols
- Conditional orders
- Hemodialysis, peritoneal dialysis, and continuous renal replacement solutions.

**Medication Order Processes**

- Ordering (physician or other clinician)
- Preparation and labeling
- Medication order review
- Dispensing and distribution (including interface to automated dispensing devices)
- Administration and documentation
- Medication schedule changes
- Holding orders
- Code medications
- On-call to OR or procedures
- Future orders
- Negative orders
- Charging

1

2 **Figure 6. Types of medication orders and processes that should be reviewed and**  
 3 **included in CPOE design.**

4

5 The description of the current medication-use process should be developed from  
 6 a number of sources: observation, paper order sets, discussion with clinicians,  
 7 and the knowledge of those who have worked on previous process improvement  
 8 efforts in the organization. This is the perfect time to engage staff pharmacists

1 who service the various areas in your organization. Pharmacists are often the  
 2 experts as they see the end-to-end process that may be invisible to physicians  
 3 and nurses. Implementers should strive to understand the current state of the  
 4 medication-use processes in terms of the components listed in Table 1, which  
 5 also lists the form best used to represent the component.

6

<b>Component</b>	<b>Representation</b>
Activities performed	Process flow chart
Strengths and weaknesses of the current processes	Text
The person(s) performing the activities	Text
The information needed in order to perform the activity	Text
The tools and systems used to perform the activity	Flow chart
The outputs of the activity and where they are sent/recorded	Text
The time/effort used to perform the activities	Text
The barriers, constraints, reductions in efficiency, and limitations on the activity	Text

7 Table 1. Components of the medication-use process and formats best suited to  
 8 representing them.

9

## 10 **Developing the Future Medication-Use Process and System Design**

11 Once the current state of the medication-use process is well understood, one or  
 12 more instances of the future state (depending on the plan for phasing in the  
 13 CPOE system) can be designed. This future state should be designed to meet or  
 14 exceed the current levels of service and other important designated metrics and  
 15 priorities (e.g., patient safety, first-dose delivery time) and any desired  
 16 improvements. The desired benefits of the CPOE implementation should be  
 17 clearly identified and the process and system design should make those benefits  
 18 possible. The design should include the practices, work processes, and  
 19 technological components in an integrated fashion. General process design

1 principles are listed in Figure 7.

2

### 3 **CPOE Process Design Principles**

4  
5 Standardization of order entry and management information and workflows across the  
6 organization to the degree possible

7 Simplifying processes.

8 Creating an effective multidisciplinary, team-based approach (i.e. improving communication).

9 Designing mechanisms for reporting and learning from errors.

10 Seeking redundancy through use of technology to support clinical decision making.

11 Avoiding reliance on memory.

12 Using constraints and forcing functions where appropriate

13 Simulating planned and unplanned events for how people interact with each other and  
14 technology.

15 Planning for failure and designing for recovery.

16 Providing access to a core set of integrated clinical information at the time and point of decision-  
17 making.

18 Figure 7. General CPOE process design principles.

19

20 The future state design should be a multidisciplinary effort that considers the  
21 entire medication-use process, even though many parts of the process may not  
22 change or may not change much with CPOE implementation. It is important to  
23 maintain the continuity and integrity of the process by making sure that the  
24 design of the component activities are compatible and completely account for  
25 manual or previously automated processes.

26 The draft future state design is typically done with a small multidisciplinary  
27 group of clinicians (core team) who understand the current process and the  
28 capabilities and limitations of the CPOE system. This group should consist of  
29 clinicians who order (specialty physicians, nurse practitioners, and clinical  
30 pharmacists), dispense (pharmacists, technicians, and specialty nurses) and  
31 administer (nurses and specialty physicians) medications. The charge of this

1 group is to weave into the system design the following factors:

- 2 • Existing work processes and systems.
- 3 • Best practices.
- 4 • New systems, with consideration for their capabilities and limitations.
- 5 • Physical limitations (e.g., space, facility issues, staffing limitations).
- 6 • Political issues (e.g., organizational priorities, limited physician
- 7 cooperation or interest in CPOE).
- 8 • Desired benefits and performance improvements.

9 This redesign typically starts with a high-level process flow diagram that  
10 describes the activities performed by each member in the medication-use  
11 process, coupled with demonstrations of the system capabilities and flow.  
12 Through successive iterations, the workflow and system design is brought into  
13 increasing levels of detail and expanded to address the factors listed above.  
14 Once the core team is satisfied with the design, practicing clinicians can be  
15 brought in to validate and improve the design. The clinicians involved in these  
16 process redesign sessions should be experienced and practicing clinicians who  
17 understand the current process and will likely find the potential issues with the  
18 new processes. These process redesign sessions should be as practically  
19 focused as possible and should demonstrate prototypes of orders and output  
20 from the system. These sessions should provide a forum to discuss what to do  
21 and how it will be done. The redesign will likely take at least three or four  
22 sessions to cover the necessary detail of all the affected processes. The  
23 information gathered from these sessions can then be used to complete the

1 process and system design and build the policy and procedure and training  
2 documents.

3 **Other design considerations.** It should be determined whether there are  
4 required elements at provider order entry in order for the pharmacy to process  
5 orders (e.g., patient allergies or weight). Integrated systems start to break down  
6 the silos that physicians, nurses, and pharmacists sometimes practice in. There  
7 should be one shared field for allergy or weight documentation, so any expected  
8 workflow changes need to be discussed prior to implementation. The current  
9 process for handling allergy conflicts or drug interactions should be examined  
10 and it should be determined how users will handle an alert in a critical or time-  
11 dependent area, such as the emergency room. It should also be determined  
12 whether there is a need for an additional set of elements for order processing  
13 (e.g., laboratory or other results). CDS will be covered more deeply in  
14 subsequent guidelines.

15 **Medication use within the context of CPOE and the EHR.** Whether  
16 your organization implements CPOE alone or along with other parts of the EHR  
17 (such as the electronic MAR [eMAR]), other parts of the medication-use process  
18 will be affected. To meet the long-term goal of a complete EHR, all medication  
19 orders should be included in CPOE. Having disparate ordering systems (e.g.,  
20 manual and electronic systems) causes confusion, creates additional work for  
21 health care professionals, and presents risks to patient safety. The hospital must  
22 recognize that CPOE may increase the amount of time the medical staff spends  
23 on prescribing medications, at least in the beginning.<sup>33,34</sup> Therefore, there must

1 be considerable dialogue with the medical staff about their role in the overall  
2 medication-use process. It is important that they understand that CPOE is an  
3 effective way for them to communicate their orders and improve the timeliness,  
4 accuracy, and safety of patient care and that efficiency should improve over time.  
5 The hospital should provide incentives for prescribers to utilize the system and  
6 disincentives for giving verbal orders or continuing to handwrite orders. To  
7 facilitate use of the system, prescribers must have access to the CPOE system  
8 from multiple venues, including their offices and homes and via wireless  
9 computers.

10 All new orders should be verified by a nurse as well as by a pharmacist,  
11 and this verification should be documented in the EHR. The nurse should work  
12 directly in the EHR for all clinical documentation, including medication  
13 administration. To comply with the "five rights" of medication administration,<sup>35</sup> a  
14 workstation must be available close to the patient's bedside with ready access to  
15 that patient's EHR, MAR, and other relevant information. Figure 8 lists some  
16 design considerations for the workgroup as new workflows are designed for  
17 different clinical scenarios.

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**Design Considerations**

- How do orders post to the MAR, and what is the relationship between the MAR and intake/output flowsheets?
- Are there other documentation flowsheets that are also used or needed (e.g., patient-controlled anesthesia, continuous renal replacement therapy)?
- Do orders need to be approved by pharmacy before a nurse can chart or administer the first dose of the medication?
- Can nursing staff easily tell when the order has been verified by pharmacy?
- Is there a mechanism to have critically needed orders available on the eMAR before pharmacist review?
- What medication information is displayed to the nurse for administration (i.e., both brand and generic names)?
- How are orders sorted on the MAR (e.g., are as-needed orders separated from scheduled orders)?
- Are administration instructions and notes required (e.g., do not administer ciprofloxacin with Maalox)? Will they be supplied from the CPOE system or from the pharmacy system?
- Are nondrug items needed on the MAR (e.g., wet to dry dressings)? If so, how will these items be entered (i.e., are these orders that pharmacy must review and approve)? Can some type of treatment administration record be created for these items?
- Is there a chart on removal from an automated dispensing cabinet or are auto-charting functions in use?
- Does the health system have plans to develop a bar-coding system for medication administration?
- Override rates of alerts by both pharmacists and providers to better set sensitivities for the warning
- Order verification times by pharmacists to determine turn-around times for different priorities of medication ordering.
- Compliance to clinical practice guidelines and order sets.
- If integration of the CPOE system is available with automated dispensing devices, then monitoring for overrides would be warranted.
- Monitoring free-text orderables in the system, to better address the provider's needs and provide guidance for appropriate formulary build.

Figure 8. Design considerations for the workgroup as new workflows are designed for different clinical scenarios.

Computer terminals (both wired and wireless) should be available in sufficient quantities so that no clinician has to wait to use one. It is critical that the technologies used for stationary and mobile computing be matched to the

1 anticipated workflow. It is likely that stationary PCs, handheld devices (e.g.,  
2 personal digital assistants, tablet and cart-mounted PCs) will all be needed for  
3 some part of medication ordering for some types of users. The CPOE system  
4 and the pharmacy information system should be available on the same  
5 computer, to facilitate switching between systems.

6

### 7 **Planning for CDS**

8 Although CPOE is an important part of an organization's plan for improved safety  
9 and quality, the addition of CDS to the EHR and CPOE is vital for the prevention  
10 of adverse events and improvement in patient outcomes.<sup>16, 19, 20</sup> A full discussion  
11 of CDS is beyond the scope of this document, but any plan for CPOE should  
12 include a strategy for CDS. First and foremost in that plan, an organization must  
13 recognize that to realize the benefits of CDS, the CPOE system must be  
14 accepted by clinicians and used effectively. Poor design or too many alerts could  
15 lead to system rejection or, even worse, unanticipated outcomes such as  
16 increased errors or adverse events.<sup>24, 25, 36-39</sup>

17 CDS can be defined as providing the appropriate clinician(s) with clinical  
18 knowledge and/or patient information intelligently filtered and presented at  
19 appropriate times to enhance patient care.<sup>40</sup> CDS is not just interactive alerts.

20 CDS has many forms, including:

- 21 • Order sets (as an expression of best practices)
- 22 • Automation of follow-up for potential ADE's
- 23 • Automated ADE detection based on diagnostic results and patient

1 notes.

- 2 • Automated reorder/review notifications
- 3 • Field edits/restrictions (e.g. only certain doses can be entered for
- 4 certain meds)
- 5 • Presentation of relevant information at appropriate times (e.g. drug
- 6 levels when a drug is being reordered)

7 Because CDS has such a broad definition, the line between CDS and CPOE is  
8 not always clear. Basic forms of CDS, such as fully defined order sentences and  
9 order sets, are an important aspect of CPOE and can decrease errors while  
10 enhancing clinician acceptance of the system.<sup>26,27</sup> This type of basic CDS makes  
11 it easy for clinicians "to do the right thing" rather than warning them with an alert  
12 after the fact and is a vital part of any CPOE implementation.

13 Other types of CDS, including checks for allergies, drug-drug interactions,  
14 drug duplications, and dose range checks, are typically delivered via an  
15 interruptive alert to the user. Such CDS should be considered before CPOE  
16 implementation, but designers should keep in mind that a high number of alerts  
17 may cause clinicians to ignore alerts altogether and may even threaten clinician  
18 acceptance of the system. The way alerts are prioritized and presented to the  
19 user may be as important as which alerts are presented. Alerts for very serious  
20 clinical situations may be ignored when lost in a sea of less important ones.<sup>41</sup>  
21 Many vendor systems need significant customization to bring the number of  
22 alerts to an appropriate level, particularly for physician recipients.<sup>36-38</sup>

23 The strategy for prioritization of CDS should be defined as early as

1 possible, and pharmacists should take a leading role in all medication-related  
2 CDS. It is likely that organizations will be anxious to implement CDS along with  
3 CPOE. Pharmacists should ensure that the CPOE system is implemented with  
4 basic CDS, such as order sets and sentences, while using appropriate caution  
5 when implementing alerts.<sup>26</sup> Although vendor systems are continuously  
6 improving and may allow tiering of alerts, there is typically a significant amount of  
7 work necessary to bring the number of alerts to an acceptable level for all parties  
8 involved. The combination of pharmacists' clinical knowledge of drugs and their  
9 experience with the interruptive alerts present in pharmacy information systems  
10 for years provide pharmacists with a unique understanding of the many  
11 implications of implementing medication-related CDS. Pharmacists should work  
12 with medical leadership, either through the P&T, informatics, or another  
13 multidisciplinary committee, to decide how and when medication-related CDS will  
14 be added to the system. The design, implementation, and optimization of CDS is  
15 an exciting area of opportunity for pharmacist informaticists now and in the years  
16 to come.

17

## 18 **Elements of a Safe CPOE System**

19 **Minimum features and functions.** The implementation group and key  
20 stakeholders should consider what features and functions of the CPOE system  
21 are desired both now and in the future. Starting with a pilot group of users allows  
22 experience with the system to build and permits users to work through some  
23 process issues before system usage is widespread. Any pilot should be brief,

1 with plans for a roll-out shortly after addressing the major discoveries. A highly  
2 sophisticated system may take so long to develop that interest is lost, or it may  
3 be too sophisticated or rigid in its initial application to be well accepted.

4 An important consideration during CPOE implementation is the  
5 determination of which functionalities are required for go-live. CPOE will always  
6 be a work in progress, and there will be opportunities for modifications and  
7 enhancements. At a minimum, a CPOE system must incorporate all existing  
8 manual ordering processes, including such complex medication orders as  
9 epidurals, patient-controlled analgesia, weight-based dosing, and total parenteral  
10 nutrition, along with critical patient safety functionality driven from known internal  
11 or external sentinel events. An agreed-upon list of basic functionality should be  
12 established in order to ensure a timely yet successful go-live.

13 **General features and functions.** The user interface is often the most  
14 problematic aspect of CPOE. Users have been reported to place orders on the  
15 wrong patient, and to select the wrong item (or wrong feature of an order)  
16 unintentionally because they didn't use selection lists properly. The CPOE user  
17 interface must incorporate appropriate human-factors engineering to avoid risk-  
18 prone workflows and controls (e.g., memorized mnemonic codes or function  
19 keys, long selection lists) that have been shown to produce order-entry errors.  
20 Such controls include the. The order entry functionality should be independent of  
21 patient setting (e.g., inpatient, outpatient), and users should be able to combine  
22 data (e.g., order history) from all settings without a need for independent  
23 searches or screen selections. The system should include an online help function

1 for system navigation and provide notification if another user modifies the patient  
2 record while an order session is ongoing, without losing the session. All displays  
3 should contain the patient name, patient location, user name, and function in  
4 consistent screen locations. The system should support third-party data entry for  
5 prescribers by simultaneous display of the same session in multiple locations and  
6 default fields where possible or helpful. The CPOE system should permit user  
7 definition of data elements and fields that can be attached to any portion of the  
8 database. The system should permit user-friendly, error-free medication order  
9 processing by providing the functionalities for the CPOE interface and order  
10 processing listed in Figure 9.

#### 11 **CPOE Interface**

- 12 • Multiple active sessions on one display (i.e., ability to put a current order session on hold  
13 and review other information, then return to the original work session without losing the  
14 work in progress).
- 15 • Side-by-side viewing of active order lists and any system-maintained order list (e.g., a  
16 standard order set, personal favorites list, or critical path order set).
- 17 • Alignment of orders by department while in side-by-side view.
- 18 • Switching between applications on the same display without exiting order functions.
- 19 • Utilization of all functions via either keyboard or mouse.
- 20 • Forward and backward navigation anywhere in the application.
- 21 • Access to the Internet from anywhere in the orders application.
- 22 • Access from multiple locations (e.g., sign-on, viewing, data entry, and verification at  
23 clinical or remote location).
- 24 • Order entry with minimal (<3) screen flips and user definition of defaulted fields.  
25

#### 26 **CPOE Medication Order Processing**

- 27 • Ability to return user to previous screen.
- 28 • Online access to error message documentation.
- 29 • Hospital-defined error messages.
- 30 • Ability to audit and track all errors and alerts.
- 31 • Robust search functionality available from all screens.
- 32 • Support for coding all diagnoses, tests, and procedures with institutional, departmental,  
33 and user-definable subsets of preferred terms (e.g., the appropriate edition of the *Inter-*  
34 *national Classification of Diseases*<sup>42</sup>, SnoMed CT<sup>43</sup>, or others).  
35

- 1 • Ability to establish cross-references for tests or procedures, including:
  - 2 ○ Information regarding the name of a procedure or test (i.e., the ability to use
  - 3 alternate names for a procedure).
  - 4 ○ Information regarding indications for, execution of, cost of, and medical
  - 5 literature pertinent to a procedure.
  - 6 ○ Diagnosis codes that can be restricted based on type of exam or test.
  - 7 ○ Diagnosis code restrictions that staff can override by direct entry of the code or
  - 8 access to full table for lookup.
  - 9 ○ Ability to enter a diagnosis code along with reason for exam.
  - 10 ○ Ability to maintain orders online for the duration of the patient stay and to
  - 11 display the status of the orders (e.g., open, in process, completed, scheduled to
  - 12 expire, expired) during order inquiry.
  - 13 ○ Ability to store, display, and print patient test instructions as well as preparation
  - 14 instructions for the order.
- 15 • Ability to perform global set-up changes (i.e., changes to a master file table element can
- 16 be optionally set to automatically populate all relevant items throughout the table).
- 17 • Ability to clearly note and color-code active orders.
- 18 • Option to have active orders remain visible on the same screen while writing new orders.
- 19 • Ability to view all orders, including stopped and interrupted (partially entered) orders.
- 20 • Automatic assignment of unique order identification numbers used in mapping to other
- 21 systems, with the order identification number large enough, or based on an algorithm, so
- 22 that such numbers are not repeated within 5 years.
- 23 • Ability to retain multiple order numbers or other unique identifiers from other systems.
- 24 • Flags that denote order status.
- 25 • Option to manually update order status, with the ability to restrict such updates to specific
- 26 order items or specific users or user classes.
- 27 • Ability to create user-defined order status.
- 28 • One-step cancel/reorder process.
- 29 • Discontinue, discontinue/renew, cancel occurrence, and hold order functions.
- 30 • Automatic calculations.
- 31 • Option to input order information using free text.
- 32 • Ability to search for, track, and audit free text orders.
- 33 • Ability to drill down for detail from every screen.
- 34 • Ability to drill down to the following during the order entry process:
  - 35 ○ Medication and doses, since initial orders include suspended and discontinued
  - 36 orders.
  - 37 ○ Termination date and time of current orders.
  - 38 ○ Allergies (coded).
  - 39 ○ Patient diagnoses (coded).
  - 40 ○ Demographic information.
  - 41 ○ Visit information (medical).
  - 42 ○ Physicians responsible for the patient (resident, attending, and consultant
  - 43 physicians, at a minimum).
  - 44 ○ Active and completed orders with dates and times.
  - 45 ○ Patient location and service.
- 46 • Modules with data specific to clinical specialties, including sets for reporting results,
- 47 CDS, and order sets.

48  
49 Figure 9. Functionalities for CPOE interface and order processing.

1           **Levels of access.** The team will need to determine the levels of access  
2 permitted to staff throughout the hospital. The team may find it easier to begin  
3 with the current level of privileges for existing systems.

4           In general, pharmacists require a high level of access because they cover  
5 multiple areas, alter or discontinue orders, and enter verbal orders. There may be  
6 different levels of access within the pharmacy department (e.g., actions by a  
7 junior pharmacist, intern, or resident may need to be reviewed by a senior  
8 pharmacist, and pharmacy technicians may require different levels of access  
9 depending on duties). Staff may also need off-site or alternative site access.

10           In addition to pharmacy personnel access, the design team will need to  
11 determine levels of access for other staff members. This should include  
12 physicians: attendings, specialists, consultants, community staff with privileges,  
13 residents, other trainees, fellows, and possibly medical students. Medical Staff  
14 Executive Committees or P&T Committees may be able to make  
15 recommendations for appropriate access based on existing policies, Nursing will  
16 have similar access issues that could be addressed by practice committees and  
17 existing policies. Other ancillary staff will need to be granted access depending  
18 upon the orderables that will be built within the system and routed to the  
19 appropriate department for action.

20           **User levels and co-signatures.** The CPOE system should permit  
21 restriction of medication orders by user type, individual order, or class of order.  
22 Each medication order should indicate the name and user level of the ordering  
23 party. The system should support the entry of unverified orders and the editing

1 and verification of unverified orders, and this function should be role-based and  
2 restricted. The system should also support the creation of alerts or reminders for  
3 orders that require a co-signature. The pending prescriber co-signature name  
4 should default into the field from service, team, or coverage schedules, and there  
5 should be an option to override the name. The system should provide the ability  
6 to require that all orders be countersigned prior to placing a discharge order.

7 **Medication order status.** Considerations regarding medication order  
8 status include the following:

- 9 • Must all orders be reviewed by a pharmacist before they are active or  
10 posted to the MAR?
- 11 • If the answer to the above question is yes, how will the organization  
12 handle urgent medications that are administered before pharmacist  
13 review?
- 14 • Should the CPOE system have some medications on override for urgent  
15 use? Are these medications always on override or are there alternative  
16 methods for ordering them?
- 17 • Does the pharmacy have sufficient staff to deal with the volume of orders?  
18 Pharmacy will potentially see all changes, IV fluid orders, discontinuation  
19 orders, and titration orders. Design considerations will need to address the  
20 disposition of the orders prior to implementation.
- 21 • If a prescriber enters and then changes an order, how are those two  
22 orders reconciled into one order?
- 23 • How does the system handle an order by a physician assistant or student

1           that requires a co-signature before becoming active?

- 2           • Do hold orders need a defined duration to be accepted? Do these orders  
3           automatically discontinue if on hold for a certain amount of time?

4   Except in urgent situations as described by The Joint Commission, a pharmacist  
5   should verify every medication order prior to drug dispensing and administration.

6   Once verified by a pharmacist, the order should populate the pharmacy computer  
7   system, generate labels and other items necessary for dispensing, release the  
8   drug in the automated dispensing device (if applicable), and populate the  
9   electronic MAR as an active order. The order should be available to the MAR as  
10   soon as it is placed, but it should be clear to the nurse whether the pharmacist  
11   has verified the order or not.

12           **Order history.** The CPOE system should permit viewing of orders from all  
13   previous patient encounters regardless of enterprise location, setting, or patient  
14   status. The system should be capable of storing and retrieving previous patient  
15   order lists and sorting, reporting, and printing patient order lists by date and date  
16   range, setting, patient status (e.g., discharge), service, department, and provider.

17           The system should allow pharmacists to maintain MARs and permit online  
18   updates, provide online capability to automatically generate a hard copy of MARs  
19   for downtime back-up, provide the ability to display and/or print patient  
20   medication profiles or MAR on demand or at a specified time, and include the  
21   ability to have multiple formats that are definable by systems-level staff.

22           **Documentation in the MAR.** The CPOE system should seamlessly build  
23   the MAR from orders in real time. Some institutions may want medication

1 administration time changes to be modifiable from the MAR, and the MAR may  
2 have a bi-directional interface to the pharmacy information system (if it is not an  
3 integrated system). The system should provide the ability to enable bar-code  
4 medication documentation. Pharmacist order validation should automatically  
5 update the MAR. The pharmacy and nursing departments should work together  
6 to ensure that the MAR is designed to be readable and user-friendly from the  
7 nurse's perspective. Pharmacists and nurses should have the ability to add or  
8 delete patient allergies, enter special instructions, change administration times,  
9 and place medication orders on or remove them from hold or conditional status.  
10 Changes made to administration times in the MAR should back-populate the  
11 CPOE and pharmacy information systems.

12

### 13 **Medication Orderable Design and Build Considerations**

14 The design and build of the medication orderables are key tasks in implementing  
15 the CPOE system. Care should be taken in designing and building the formulary  
16 or formularies, as well as the standard orders and order sets that are built from  
17 the formulary. The pharmacy department must have direct involvement in this  
18 task.

19       The CPOE formulary cannot be simply a copy of the pharmacy inventory.  
20 Prescribers need to have the orderables constructed to match how they order  
21 medications, rather than how the pharmacy maintains medication inventory. In  
22 addition, care must be exercised when deciding on the default dose values for  
23 items that will be displayed to the prescriber and developing the construction of

1 standard orders. Medication errors can result from a hurried prescriber accepting  
2 the default that he or she assumes must be correct.<sup>24</sup> The CPOE system should  
3 be able to generate formulary lists by generic name, trade name, and dosage  
4 form.

5       The CPOE system should support multiple medication formularies  
6 concurrently and allow routine online updating of the formulary and clinical  
7 checks of information without system functionality downtime. The system should  
8 provide authorized personnel the ability to maintain and display the formulary  
9 with pertinent data (e.g., formulary code, generic name, trade name, national  
10 drug code [NDC], or AHFS number), while limiting access to certain formulary  
11 data by role. The CPOE system should include the ability to identify whether an  
12 IV with medication additive is to be handled as a large-volume IV or as a  
13 medication to determine the print location. The system should allow the ability to  
14 make changes to the medication identifier (NDC or RxNorm identifier),  
15 communicate those changes to other systems, and receive changes from other  
16 systems.

17       **Parent-child relationship of medication data.** The parent-child  
18 relationship of medication data is important in the case of IV medications and the  
19 diluent used for administration, two drugs to be taken together (e.g., hydroxyzine  
20 and meperidine in a single syringe), or a drug and a measurement requirement  
21 (e.g., digoxin and pulse rate). The CPOE system needs to be able to handle  
22 formulary items that have a parent-child relationship. The system needs to make  
23 it easy for the prescriber to order these types of formulary items. The system

1 should be flexible enough for the prescriber to select the drug form and size or  
2 indicate the diluent for an IV piggy-back when ordering if so desired, or to allow  
3 these choices to be made once the order reaches the pharmacy system.

4 **Order sets.** Requiring providers to use a CPOE system requires a change  
5 in workflow, and many fear it may increase the time physicians spend processing  
6 orders.<sup>34</sup> Configuring pre-constructed order sentences and order sets prior to  
7 implementing CPOE may increase speed, accuracy, and acceptability of  
8 CPOE.<sup>26, 27, 44</sup> Careful deliberation is needed prior to the creation of CPOE order  
9 sets, including consideration of how order sets are currently developed (e.g., by  
10 department or by individual practitioners), what the process to propose and  
11 review order sets is, and what level of medical oversight is in place for order set  
12 development and use. It is also important to understand ordering patterns when  
13 developing order sets for use by clinicians. Many organizations use this  
14 opportunity to improve and standardize across important aspects of care, such  
15 as post-op nausea and vomiting or pain management, as well as move to  
16 evidence based order sets from their legacy order sets.<sup>27</sup>

17 The system should permit development of specific admission pathways  
18 (e.g., order sets capable of including any type of order and intervention) and  
19 integrate with data documented elsewhere in the EHR (e.g., medical histories,  
20 medication lists, laboratory results, diagnostic images, clinical documentation,  
21 progress notes, and narrative summaries, such as operative reports or  
22 consultations). Order set availability should be limitable by user, user role,  
23 location, service, or patient status or diagnosis. The system should permit an

1 unlimited number of orders within an order set and an unlimited number of order  
2 sets within departments, across departments, and with user-definable time  
3 parameters. Order sets can include nursing orders, tests, medications and  
4 should include appropriate laboratory tests at appropriate intervals to assist in  
5 monitoring therapy. Though many systems allow users to create and save their  
6 own order sets in a favorites list, this flexibility needs to be weighed against the  
7 desire to standardize care by allowing hospital-based order sets only.<sup>27</sup>  
8 Discontinuation of an order set should trigger the automatic ability to review, edit,  
9 or discontinue all linked orders.

10       Because the CPOE system may permit initiation of standard order sets  
11 with a single action (mouse click, keyboard stroke, etc.), order sets' ease of use  
12 of may lead to inappropriate or excess medications being ordered. Order sets  
13 should be allowed to include linked orders, but orders grouped in a standard  
14 order set need not be linked. The institution should decide if all orders in the set  
15 are going to be active once they are signed or if prescribers are required to  
16 actively check and click on each medication before signing.

17       The CPOE system should require designation of an owner (i.e.,  
18 department, service, person, or role) for each order set. CPOE order sets should  
19 be reviewed on a periodic basis for therapy updates. Item and service  
20 maintenance should be performed at the departmental level, with updates in item  
21 or service definition flagged for review by the owner of the standard order set  
22 containing that item or service (i.e., the change triggers a report that the order set  
23 requires review). The CPOE system should support restriction of departmental or

1 service standard order set creation or editing by role or individual.

2       The CPOE system should support standard order set maintenance and  
3 review by:

- 4       • Grouping order sets by department/service.
- 5       • Dating the creation and review of order sets.
- 6       • Providing periodic (user-defined intervals or dates or as needed) reporting  
7       of standard order sets requiring review by owner (department, service,  
8       person, or role)
- 9       • Permitting global changes.

10       **Critical pathways and protocol order sets.** Critical pathways and paper-  
11 based order sets, a very basic form of CDS already widely used in hospitals,  
12 provide a starting point in efforts to standardize care and improve quality and  
13 safety through the CPOE system. With the implementation of evidence-based  
14 order sets, organizations can provide the prescriber with a direct link to the  
15 electronic literature supporting the recommended practice. The work of  
16 synthesizing and classifying the available evidence is done by organizations such  
17 as the National Guideline Clearinghouse<sup>45</sup> and the Cochrane Database of  
18 Systematic Reviews.<sup>46</sup> Organizations may incorporate these guidelines into  
19 electronic order sets and critical pathways, in addition to providing the link to give  
20 prescribers point-of-care access to the evidence-based literature at the time of  
21 order entry.

22       The CPOE system should support all functions listed under general order  
23 sets for critical pathways and protocol order sets. The system should provide a

1 default set of protocols that are available by service and physician and a default  
2 set of protocols that are restricted by location. The CPOE system should include  
3 an alert system for orders not completed within user-defined time parameters or  
4 time parameters required by critical paths or research protocol.

5 **Medication order linking.** The CPOE system should include the ability to  
6 identify orders as linked and sequential and to specify intervals as well as  
7 cascade changes in future orders to maintain sequence and timing. It should  
8 permit an order stop to automatically bring up any linked orders for re-verification,  
9 with the default being to cancel unless re-verified. The system should provide  
10 automatic re-sequencing of future orders if any item identified as sequential is  
11 moved on the timeline, and it should permit linked orders (i.e., reflexive  
12 occurrences that trigger other procedures) that cascade through multiple levels.

13 **Favorites lists.** The CPOE system should permit use of favorites lists by  
14 individual user that may include orders for multiple departments (e.g., laboratory,  
15 pharmacy, radiology). The system should provide default "Sigs" (dose route  
16 frequency, length of order) that are user-definable at the nursing unit level and  
17 that have discharge orders or discharge worksheet functionality. The system  
18 should provide default Sigs and permit users to save favorite Sigs in user  
19 favorites. Users should be able to create favorites lists that include orders from  
20 multiple departments on one list. Favorites lists should be fully editable on an ad  
21 hoc basis for an active order session, and user-specific favorites lists should be  
22 editable by the user. Users should be able to designate any order list as a  
23 favorite and may name or rename the list ad hoc (i.e., the save function

1 automatically prompts for name, defaulting to the existing name if available).  
2 There should be an option to save an order list as a favorite, either as a new  
3 favorite or as a replacement for an existing favorite; that option should be  
4 available during any ordering session. Favorites lists should be allowed to  
5 contain ordering details that default into the order, and default details should be  
6 editable and replaceable during order entry. The CPOE system should support  
7 context-specific favorites lists by user, nursing unit, service, and diagnosis, and  
8 by combinations of user and diagnosis or by combinations of user, diagnosis,  
9 and setting (e.g., outpatient, inpatient). User favorites lists should be copied and  
10 shared easily, and the system should allow favorites lists to be built by opening  
11 and then editing standard order sets and saving as a favorite. Favorites lists may  
12 also include reminders.

13

#### 14 **Pharmacy Department Considerations**

15 The ideal CPOE system will have be integrated with or have a fully functional bi-  
16 directional interface with the hospital's pharmacy computer system so that orders  
17 entered or modified in one system will populate fields in the other system,  
18 avoiding the need for dual order entry. The bi-directional feature of an interface is  
19 important because it prevents potentially dangerous discrepancies between data  
20 in the pharmacy and EHR systems and removes the transcription step of the  
21 medication use process. In addition, if the distribution and administration  
22 components of medication management are not linked, then documentation and  
23 billing will not be either, causing more opportunities for error and audit problems.

1           In their day-to-day interaction with the CPOE system, pharmacists should  
2 be working primarily in the EHR, which has all relevant patient information fully  
3 integrated with the CPOE module. The pharmacist's roles include verifying all  
4 orders, reviewing and responding to alerts, and clinical monitoring of the patient.  
5 The pharmacist should have security privileges to enter and modify orders under  
6 protocol (such as formulary or formulation changes). If a pharmacist verifies an  
7 order in the CPOE system, that order should appear as an active order in the  
8 pharmacy computer system without the need for additional action or  
9 manipulation.

10           Pharmacists should receive and work with orders electronically in a queue.  
11 Patients with stat orders should appear at the top of the list and be clearly  
12 differentiated from less urgent orders. Pharmacists should have the ability to  
13 screen their view of orders based on the nursing units they are responsible for on  
14 a given shift. At no time should a pharmacist be able to view orders for more than  
15 one patient at the same time.

16           When working with paper orders, pharmacists often gain insight into the  
17 medication orders from the context of the surrounding patient care orders. CPOE  
18 systems should preserve that context so that pharmacists can view an order in  
19 terms of the other therapies, tests, and nursing care surrounding it.

20

## 21 **Communications Between Departments**

22 The CPOE system should allow alerts for transmission of pending orders via e-  
23 mail, pager, alpha alert, message board, and other applicable institution-specific

1 technology. Order notification should be allowed via printout, work queue, e-mail  
2 message, system message, or pager. The default method for receiving  
3 notification of orders should be definable by the department or service, and the  
4 system should support special notification methods for specific services or items  
5 different from the departmental or service default, without affecting summary  
6 reporting by department. Users should be able to print orders to alternate  
7 locations and to send messages, orders, and alerts to additional departments  
8 (including information about scheduling and priority of orders) as a single order is  
9 being entered or completed. The CPOE system should have an option that order  
10 placement generates user-defined worklists. The system should also provide the  
11 ability to e-mail patient and preparation instructions and to reference on-call lists.

12

### 13 **Education and Training of Health Care Providers**

14 The rate of adoption of the new CPOE system may be directly linked to the  
15 extent of training provided to users prior to and during the implementation. One  
16 cannot spend too much time training users, as the change the new system  
17 entails will be overwhelming. This training can be in the form of formal classroom  
18 training, local expert training or "at-the-elbow" support and training during go-live.  
19 Organizations may find the most success in using a combination of all three. The  
20 more familiar the users are with the system at the time of go-live, the easier the  
21 transition will be.

22         The facility should train and employ a group of prescriber "super users."

23 These users will support the go-live, help the institution refine the CPOE system

1 to be as efficient as possible, and serve as liaisons to the other members of the  
2 medical staff. There should be ongoing, open dialogue with leadership and  
3 medical staff members to continually improve the system.

4 Each training session should focus on a specific aspect of the system (as  
5 described below) and be geared toward the type of user, since utilization will  
6 differ by clinician type (e.g., physician, respiratory therapist, nurse, pharmacist,  
7 laboratory technician).

8 **Overview of system.** The initial introduction to the system should  
9 familiarize the user with the layout of the system. It should review toolbars and  
10 menus of each application. The first glimpse should include any definitions that  
11 are new or to which meanings may be different from the current process.

12 **Accessing data.** This section of training should familiarize the user with  
13 the various methods for accessing data. It should provide information on sorting  
14 and filtering data. Because access to data will vary based upon the type of user,  
15 separating different user types for training purposes at this stage may be  
16 beneficial, and this would be a good time to discuss security and privileges.

17 **Documenting information.** This section should teach users how to  
18 document information pertinent to their practices. These tasks would include  
19 adding basic patient information and documentation on flow sheets, as well as  
20 clinical progress notes.

21 **Orders.** The training session(s) on medication orders will be the most  
22 comprehensive. Some users will be limited to ordering tests or procedures  
23 specific to their practices. Physicians, nurses, and pharmacists, however, will

1 spend a large percentage of their time in the CPOE system working with orders.  
2 Time should be taken to demonstrate each type of order. After the  
3 demonstration, users should practice working with all types of orders that they  
4 may process in various scenarios. Though documented information may be  
5 sparse in test domains, practicing with 'realistic patient scenarios' is helpful here.

6 **Pilot project.** A pilot with a defined scope is advisable at the beginning of  
7 the implementation phase. Organizers should consider the length of the pilot,  
8 which patients will be included, what the objectives of the pilot are (e.g., testing  
9 system performance, workflow, bug identification, completeness of ordering), and  
10 what happens at the conclusion of the pilot (e.g., more programming, more  
11 testing, another pilot, or live rollout). Because user feedback is also a variable  
12 objective of the pilot, organizers should develop an evaluation tool for the staff.

13 A time analysis should be performed, comparing how long it takes the  
14 pharmacy to process orders with the CPOE system versus their previous  
15 workflow. This analysis should determine whether time is saved by eliminating  
16 manual entry of orders in the pharmacy computer system and manual  
17 development and maintenance of MARs. If the time analysis demonstrates a  
18 negative impact on workload, the facility should make appropriate staffing  
19 adjustments. These adjustments will vary, based on the percentage of orders  
20 directly entered by the prescriber, and should be continually assessed. A time  
21 analysis should also be performed comparing how long it takes nursing staff to  
22 administer and document medications in the CPOE system versus the manual  
23 system. This analysis should determine whether time is saved by eliminating

1 manual transcription of orders and manual development and maintenance of  
2 MARs. If the time analysis demonstrates a negative impact on workload, the  
3 facility should make appropriate staffing adjustments. These adjustments will  
4 vary, based on the percentage of orders directly entered by the prescriber, and  
5 should be continually assessed.

6

### 7 **Conclusion**

8 These guidelines provide guidance to pharmacists in hospitals and health  
9 systems on planning for and implementing safe CPOE systems. Pharmacists  
10 should utilize their unique knowledge and skills as part of the multidisciplinary  
11 CPOE planning and implementation team. Participation by pharmacists is critical  
12 in defining the vision, goals, and objectives of the CPOE system; establishing  
13 essential metrics to measure the success of CPOE system implementation; re-  
14 engineering the medication use process as part of CPOE system  
15 implementation; determining the functionality that ensures the safety of the  
16 CPOE system; planning for CDS; and educating and training healthcare  
17 providers to use the CPOE system. Finally, for optimal benefits to patients,  
18 organizations should realize that the implementation is merely the beginning and  
19 that pharmacists should continue to take a central role in the ongoing system  
20 optimization and continued CDS implementation.

21

22

23

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