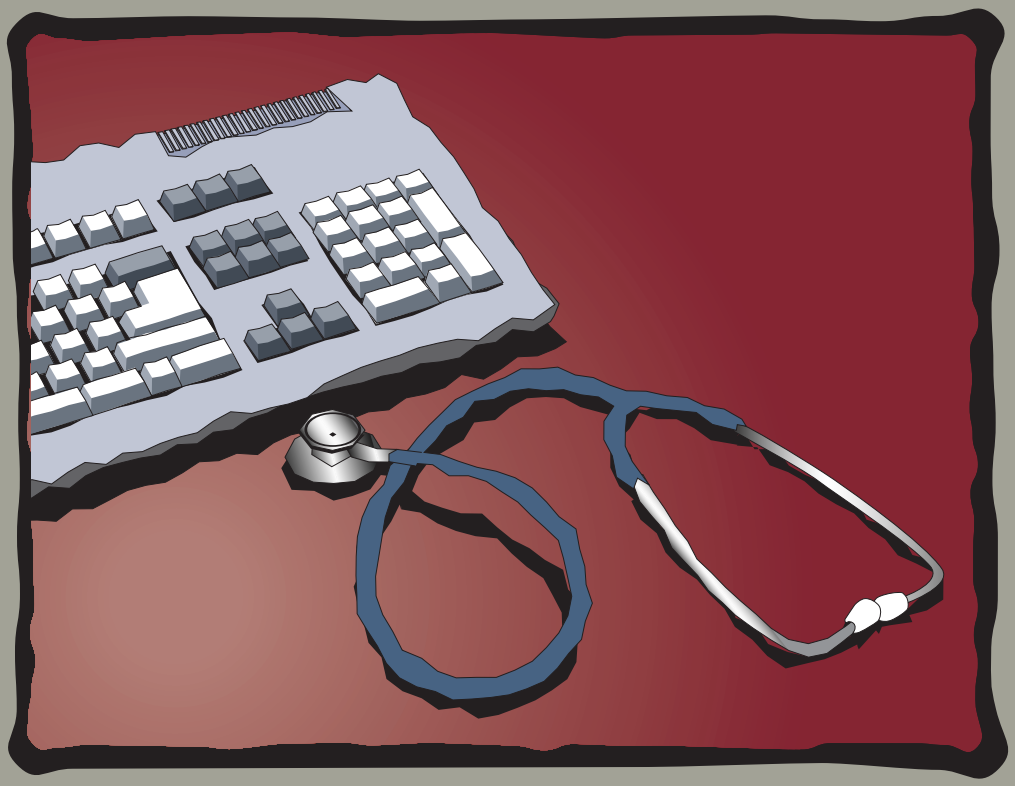

A Primer On Physician Order Entry

California HealthCare Foundation
First Consulting Group

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A Primer on Physician Order Entry was prepared for the California HealthCare Foundation's Quality Initiative by First Consulting Group (FCG), Long Beach, California, www.fcg.com. FCG provides information technology consulting, integration, and management services to healthcare, pharmaceutical, and other life sciences organizations. The *Primer* was prepared by Erica Drazen, Peter Kilbridge, Jane Metzger, and Fran Turisco, members of Emerging Practices, the applied research arm of FCG. The research team is grateful for the assistance of individuals in each of the organizations cited as case study examples.

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California HealthCare Foundation
The Quality Initiative
476 Ninth St.
Oakland, CA 94607
Tel: (510) 238-1040
Fax: (510) 238-1044
e-mail: quality@chcf.org
http://quality.chcf.org

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Table of Contents

Executive Summary

In its November 1999 report, ***To Err Is Human: Building a Safer Health System***, the Institute of Medicine pointed out that 44,000-98,000 people die from medical errors in U.S. hospitals each year. As a result, the health care industry has been focusing on Computerized Physician Order Entry (CPOE) in hospitals as an important and underutilized tool for improving patient safety.

CPOE is a computer application that accepts the physician's orders for diagnostic and treatment services electronically instead of the physician recording them on an orders sheet or prescription pad. This includes orders such as medications, laboratory and other diagnostic tests, etc. The computer can compare the orders against standards for dosing, check for allergies or interactions with other medications and warn the physician about potential problems. Much of the immediate interest in CPOE is focused on medication order entry and its potential to reduce medication errors, reported to be the largest single cause of medical errors in hospitals. CPOE systems also have been shown to reduce costs through avoided adverse events, reduced utilization and shorter lengths of stay, and to reduce unnecessary variations in care by encouraging recommended care practices.

CPOE offers these benefits because it goes well beyond merely replacing paper orders with electronic ones – it makes relevant information available at the time of ordering and applies rules-based logic to help the physician make optimal ordering decisions. To provide full value, CPOE needs to include decision support and other features that can improve the ordering process.

CPOE - What Are the Issues?

Health system executives and trustees are recognizing that they need to take a hard look at CPOE as one element of an overall patient safety strategy. The first question they are likely to ask is, "If inpatient CPOE is such a good idea, why have so few hospitals implemented it to date?" For many years, hospital executives and most vendors of hospital information systems believed that physicians would not use computerized ordering. Given the ample evidence that CPOE can improve patient safety and the growing number of implementation success stories, the time is right to start challenging those assumptions. A second reason for the slow adoption was that, because demand was low, few CPOE products were developed, and those that were available were not perfected. The current increased interest and sense of urgency to address patient safety are stimulating the vendor market to improve existing products and introduce new ones. The complexity of the undertaking – both technology and process – and the resulting cost and risk are another reason for lack of adoption in the past and residual hesitancy today. However, both

patient safety and cost pressures present a clear imperative, and advances in technology, combined with greater industry experience, have increased the likelihood of success. Implementing CPOE takes a concerted effort, strong will, perseverance and a significant capital investment. Organizations starting out need to learn as much as possible from the pioneers who preceded them, to increase their speed of adoption and likelihood of success. The early adopters who contributed much of what we know about the power of CPOE were mainly academic medical centers with homegrown systems and residents performing most of the order entry. The success stories now also include community hospitals and community practice physicians. These all tell the same story: Successful CPOE is not a technology implementation but a redesign of a complex clinical process integrating the technology at key points to enhance and optimize ordering decisions.

Technology Is Important . . .

CPOE is not a stand-alone application but rather a module of a clinical or hospital information system. Hospitals best positioned to adopt CPOE are those with clinical systems from a vendor that offers CPOE capability. Any institution replacing a hospital information system should carefully evaluate CPOE features as part of the decision. Because of the complexity and long lead times for developing this application, few if any organizations today are likely to choose the path of internal development.

When examining CPOE applications, it is necessary to differentiate between basic products focused on capture and transmission of the order ("order communication") from those designed for use by physicians (CPOE), which incorporate interactive decision support and check for allergies, drug interactions, correct dosage, etc. Certain "must-have" features ensure improvements in medication safety and quality, as well as other features that are important for ease of use and implementation. Scenarios depicting typical clinical situations are effective tools for determining the system's fit with workflow and acceptability to physicians. Physicians themselves are the best judges of what technology will help them. Purchasers also can benefit from contacting reference sites that are similar to theirs – both in terms of environment and objectives.

Beyond features and functions, CPOE needs to be highly responsive – exhibiting quick response time to speed physician ordering sessions – and reliable, to support the critical ordering process without interruption, 24 hours a day, seven days a week.

But the Organizational Challenge Is Greater

Clinical applications, especially those used by physicians, are the most difficult to implement, and many view inpatient CPOE as the most difficult of all. An examination of industry experience with CPOE reveals several critical success factors.

Leadership — Physicians lead the effort – both at the project and executive levels – with physician champions involved in all aspects. Executive leadership must be unwavering.

Operations — There is no such thing as too much attention to details of a process before, during and after implementation.

Change Management — CPOE affects workflow and process of all caregivers and ancillary departments, not just physicians. Accomplishing this change requires a commitment to serious change management. Even when things go well, there is a need to push rather than wait for voluntary change.

Support — During rollout, responsiveness and flexibility are key to working through the different needs of each new clinical area. Rollout is a significant milestone but not the end of support.

The bottom line is that CPOE is an organizational change initiative, not an IT project. It is hard work and requires broad agreement within the organization that the effort is of major importance and an organization-wide commitment to see it through.

How to Get Started

- Incorporate CPOE into your overall patient safety strategy;
- Be clear about objectives and expectations;
- Be sure to include the most in-depth decision support available in your CPOE software;
- Start building a universal understanding of the importance of the project;
- Develop a plan and assign physicians to be accountable for executive leadership and project management;
- Learn as much as you can from similar organizations that are ahead of you in adopting CPOE.

Chapter One

What Is Computerized Physician Order Entry (CPOE) and Why Has It Generated So Much Recent Interest?

Ordering — when a physician writes diagnostic and treatment orders for a patient — is undoubtedly the process in medicine with the greatest leverage over the quality and cost of care. It is the point at which clinical plans are finalized and translated into action. Therefore, the ordering process is the first line of defense in ensuring quality of care. Computerized Physician Order Entry (CPOE) is an online computer application that accepts physician orders electronically. It replaces the physician writing orders on an order sheet or prescription pad.

The current interest in computerized physician ordering has been stimulated mainly by the Institute of Medicine (IOM) report, ***To Err Is Human: Building a Safer Health System,*** published in the fall of 1999. The IOM report concluded that between 44,000 and 98,000 people die each year from adverse events in the hospital. [1] The ensuing public attention and debates about how best to move quickly to improve patient safety keep highlighting CPOE as one important tool that is currently little used in our health care system.

Other incentives are starting to fall in place. A group of employers, the Leapfrog Group, is planning to rate hospitals treating their employees according to the availability and use of CPOE, and increase adoption through their purchasing power. Changes to regulatory and accreditation processes to mandate CPOE are also inevitable.

The value of CPOE goes well beyond merely replacing a paper order with one entered on a computer. The biggest benefits of CPOE come because the computer makes relevant information available at the time of ordering (patient allergies, costs of medications, etc.) and applies logic to help the physician in making the optimal ordering decisions. For example, the computer can check and issue a warning that the patient is allergic to a drug being ordered, point out possible interactions between the ordered medication and other drugs the patient is taking, or calculate the dose based on patient weight and age, thereby avoiding lack of information about proper dosing or arithmetic errors. Given the heightened interest in patient safety, the working definition of CPOE used in the industry must include decision support and other features that can add value during the ordering process.

Three major benefits of CPOE are the reason this technology is such a hot topic today.

1. Much of the immediate interest in patient safety is focused on medication errors, which are reported to be the largest cause of adverse hospital events. [2]

Three Primary Reasons For The Lack Of Diffusion Are:

- Many hospital executives and most vendors of hospital information systems believed that physicians would not use computerized ordering;
- Because demand was low, few products were developed, and those that were available were not perfected;
- The technical and process complexities of implementing CPOE translate into a significant investment with no guarantee of success.

Previous studies have shown that ordering is the largest source of medication-related errors and that computerized ordering can reduce these errors; [3]

2. There is a compelling case to be made that CPOE can reduce costs. One study found that adverse drug events increased hospital length of stay by 1.74 days; [4] another estimated that preventable adverse drug events increased stays by 4.6 days. [5] Beyond the costs associated with adverse events, other research has shown reduced utilization of services, length of stay, and overall costs, when CPOE is implemented. [6] One early adopter of CPOE estimated that it saved more than $1 million in medication costs by guiding physicians to effective lower doses or alternative medications for just four medications; [7]

3. CPOE can be a powerful tool for reducing unnecessary variation in care by encouraging recommended practices and in increasing responsiveness to new information about patient status. One hospital found that when a decision was made to change the drug of choice, it achieved 94 percent compliance with the new recommendation in one week using computerized decision support. [7]

Though the current focus is on inpatient CPOE, more information about errors and adverse events in ambulatory care is emerging, and new products are being developed to provide similar benefits in ambulatory care. We should expect a broadening of attention and focus on computerizing prescription management very soon.

If CPOE is such a great idea, why is it not used more widely? The first papers relating benefits of physician ordering were published years ago, and some computerized ordering systems have been in use for a decade.

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Will Physicians Use CPOE?

In fact, there have been cases where physicians were not happy with computerized ordering systems and at least one was highlighted in a much-cited publication. [8] Even in successful implementations, there have been concerns and actual experience that computerized ordering takes more time. [6, 7] Many of the initial implementations were in teaching hospitals where residents did most of the order entry. Whether staff and community physicians will follow suit has been an open question with little documented experience.

However, as illustrated in the case studies discussed later, there are growing numbers of success stories, including some from community hospitals and others involving staff physicians in direct entry. Despite this, many executives still feel that "our physicians are not ready to accept computerized ordering." Given ample evidence that computerized physician ordering improves patient safety, we think it is the right time to start challenging assumptions about physician readiness.

Can We Purchase CPOE Systems on the Market?

Many of the small number of frequently cited examples of success stories in implementing CPOE are from sites that developed their own software: Brigham and Women's Hospital (Boston, MA), Latter Day Saints Hospital (Salt Lake City, UT), and Regenstrief Institute for Health Care (Indianapolis, IN). Rights to all three of these software products have been purchased by commercial companies (although some have not turned these rights into products). Several other vendor companies also have offered CPOE products for years.

The experience of early adopters of CPOE has increased the understanding of how systems have to be designed to enhance physician acceptance, and what features of a system are needed to maximize the benefits in reducing errors, decreasing costs and improving quality. This knowledge will be essential in guiding future purchasers and suppliers alike. With heightened awareness of patient safety – especially medication errors – and the impetus to better manage pharmaceutical and other costs of care, the availability of better systems will increase adoption of CPOE.

Implementing CPOE takes a concerted effort, strong will, perseverance, and often a significant capital investment. Currently, CPOE is available as a module of some hospital information systems (HIS) – not as a stand-alone application that "wraps around" an existing hospital system. Therefore, the hospitals best positioned to adopt CPOE are those that have clinical systems from a vendor that also offers CPOE. Certainly any institution considering replacing a current HIS should carefully evaluate CPOE features as part of the decision.

Can We Manage the Cost and Complexity of CPOE?

Implementing CPOE is an organizational challenge because it requires retooling a process that affects every order, every patient and every physician. Computerizing orders also requires standardizing practices that are mostly local and, for physicians, also personal. At the same time, the technology is complex because CPOE is not a stand-alone software application. It is usually one piece of a suite of clinical applications, which also must be interfaced with numerous departmental systems, such as pharmacy, laboratory, etc. For these reasons, the CPOE efforts in some organizations have been prolonged, costly, and not always successful.

Today, the urgency of addressing patient safety provides a clear imperative for hospitals to focus on being successful with CPOE, rather than debating its importance. Implementing CPOE is admittedly costly because it involves infrastructure, hardware, software and considerable process design and change management. In California's current, often precarious, fiscal environment, hospital executives understandably scrutinize costly projects more critically and expect substantial value. However, successful organizations have achieved significant cost savings from CPOE, in addition to gains in patient safety and quality, to offset the investment. Technology options are greater and more affordable now, and there is more industry experience in what it takes to be successful. Leveraging these advantages in a focused, high-profile effort should decrease the cost, time and risk, and increase the likelihood of success.

All hospitals have limited money for both capital investment and for funding operations. That makes costs a very important consideration in any change. The cost of CPOE will vary greatly based on the approach taken and the installed base of systems. Some hospitals may already have CPOE capabilities that just need to be used. If a hospital is planning a replacement of its clinical systems, CPOE would probably add only a small amount to the purchase price. If there is an installed clinical system that can be upgraded to include a CPOE application, then this capital cost may be quite modest. If all the supporting systems need to be acquired to implement CPOE, this will require a multimillion-dollar capital investment.

CPOE Within the Context of Patient Safety Programs

CPOE is only one element of a patient safety program. Furthermore, for organizations for which CPOE is not a near-term possibility, many other tactics are available for starting to take a systematic look at process and design improvements to improve consistency and reliability. The industry has produced many examples with impressive results.

One alternative to CPOE is to computerize many of the alerts available in a pharmacy system and have these alerts reviewed by pharmacists, who may

contact the ordering physician in cases where the alerts appear to be significant. Good Samaritan Regional Medical Center in Phoenix, AZ has followed this route and has implemented a system that prints out alerts in the pharmacy. A six-month study showed that the system was able to prevent 64 likely adverse drug events per 1,000 admissions.[9] Additionally, in 53 percent of the cases where alerts were generated, physicians altered their orders to be consistent with the alert recommendations. This method does require additional pharmacist time to review the alerts, with an average evaluation time of 16 minutes per order. However, this type of initial approach may be more within the reach of many organizations.

The Veterans Administration is implementing extensive technology interventions to reduce medication errors, but it is starting at the point of administration instead of at the point of ordering. [10] These systems use bar-code scanners to scan a bar code for the patient, the caregiver and the medication to ensure that drug, dose, patient, time and route are all correct. The scanners connect wirelessly to hospital information systems using radio frequencies and antennae throughout the hospital. As with CPOE, the time and financial investments are significant, given that bar codes must be generated for every episode of care and every dose of medication, and the hospital must be wired for radio transmission. Ultimately, this type of system will work best when integrated with a CPOE application that improves ordering as well. Recognizing this, the VA also is planning to implement CPOE.

Other Examples Of Process-Related Interventions Shown To Reduce Medication Errors Include:

- Improving policies and procedures for medication history taking;
- Creating preprinted standing orders for common conditions;
- Establishing protocols for high-risk medications (anticoagulation, insulin, etc.);
- Including pharmacists in ward rounds, especially in the ICUs;
- Standardizing infusion devices across care units.

The handbook produced by the Institute for Healthcare Improvement on reducing medication adverse events is a good starting point for organizations beginning to work more systematically on medication safety. [11]

Using This Guide

This guide is a primer for healthcare executives and trustees and provides a starter set of basic information. While CPOE is used for ordering a number of different types of services, much of the information in this report focuses on medication order entry, because of the current attention being focused on medication errors. The heart of the guide is organized around the two critical success factors: selecting the system to support CPOE and the work of implementing the computerized process.

In Chapter Two we talk about how CPOE works and the key features that should be included in the software.

In Chapters Three and Four, we discuss critical success factors gleaned from experience to date, first in summary form and then through case studies.

In the Appendices, we have provided additional information about functions and features of CPOE systems and contact information for some of the major vendors offering CPOE support.

We expect that interest in CPOE will continue to grow and the knowledge about its requirements and benefits, and certainly the vendors offering solutions, will all change quickly. This primer is intended to provide a starting point for your efforts in successfully implementing CPOE and for reaping the benefits of your investment.

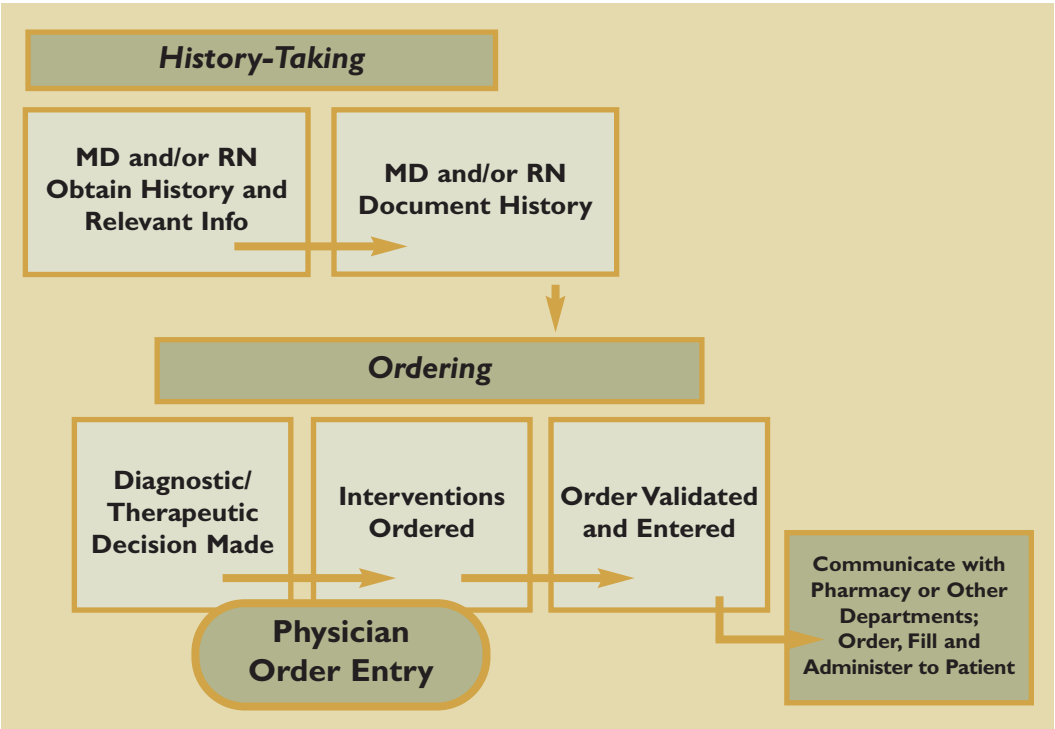
Chapter Two

How Does Computerized Physician Order Entry Work and What Are the Critical Features?

CPOE Within the Ordering Process

Inpatient order management includes many steps and the interactions of many disciplines and departments. As shown in Figure 1, physician order entry only directly impacts a small number of steps, albeit critical ones.

Figure 1. CPOE Within Inpatient Order Management



The potential contributions of computerizing physician order entry range from legibility and completeness of orders to alerts of possible contradictions. CPOE also improves the processes of communicating and organizing order information.

CPOE, especially drug order entry, is in the spotlight today primarily because of its powerful capabilities to prevent common medication ordering errors:

- Selecting the wrong drug for a condition;
- Selecting the wrong dose, route, interval, or duration;
- Overlooking drug allergies;
- Overlooking drug-drug interactions;

- Overlooking drug-laboratory value interactions (e.g., prescribing anticoagulants for a patient with low platelets);
- Overlooking drug-disease interactions.

In addition to these errors of planning, orders written by hand are prone to misinterpretation. For example, the drug name, dose, etc. may be misread and erroneously transcribed. CPOE contributes to reducing these errors primarily by supporting the orderer in creating a legible, complete order and by applying logic-based rules to patient information.

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Another benefit of CPOE can be reduced costs. Through a combination of expediting the ordering process, reducing duplicate procedures of which the orderer may not be aware, and prompting the ordering of appropriate and, in some cases, lower cost diagnostic and treatment interventions, computerized ordering can impact utilization and costs of care.

Beyond its capabilities to assist in reducing medical errors, CPOE is a powerful tool to promote standards and proper ordering practices overall. Introducing standardization through templates and order sets, as well as with logic-based prompting and alerts, computerized order entry can guide physicians to incorporate recommended practices in their care plans and alert them when new information becomes available that indicates treatment plans should be re-evaluated.

Critical Features of CPOE

The term "order entry" is applied broadly in the vendor marketplace to describe a range of software products with varying levels of capabilities.

To buy the appropriate order entry application, it is important to understand the required functions for improving the ordering process. Some products in the market are focused primarily on basic order communication and do not include all of the more advanced features for reducing medication errors, reducing costs, and reducing variation/ improving quality, as discussed above.

To gain the desired benefits of CPOE, organizations need to be implementing applications with more advanced features than most traditional order communication software.

CPOE systems are most often developed for an inpatient care delivery environment. They are not separate, stand-alone applications but rather an additional module of a Clinical Information System (CIS) or a total Hospital Information System (HIS). This significantly complicates clinical system strategy and system selection.

In several cases, hospitals have built their own applications for CPOE. Two of the most prominent of these – at Brigham and Women's Hospital and the Regenstrief Institute – are discussed in Chapter Four. CPOE applications are extremely complex and take many years to develop. Given the increasing availability of commercial products and the emerging sense of urgency in addressing patient safety in particular, it is unlikely that many hospitals will choose the path of self-development today.

Chapter Three

What Are the Ingredients for Success with CPOE?

CPOE can improve patient safety, reduce costs, and generally improve the quality and process of care delivery. A number of vendor systems are available that support CPOE, and some organizations have designed, built, and implemented their own CPOE systems. Why is it then that less than 5 percent of hospitals in the United States are successfully using physician order entry? [12]

The reason is that there are significant obstacles to successful implementation of this technology. Indeed, physician order entry is more than a technology – it is a clinical process facilitated by technology. This distinction is critical to appreciating the fundamental challenge to CPOE implementation. CPOE requires significant clinical process redesign, which in turn requires extraordinary commitment by physicians, other clinicians, and executive leadership. Although many of the same principles apply to any large-scale clinical change project, they are critical to CPOE, which some have viewed as the Holy Grail of clinical systems. [13]

Success Factors for CPOE Implementation

Ingredients necessary to successfully adopt CPOE include leadership commitment, clinical sponsors, attention to the details of process and technology, change management, training, and support and maintenance.

Leadership. An essential prerequisite for the successful implementation of CPOE is unified support for the effort from the organization's medical and executive leadership. This commitment must extend beyond the concept of CPOE, to:

- Consensus on the objectives of CPOE: Why do we wish to pursue this? What do we expect to get out of it? How will we measure success?
- Support for the project budget;
- Support for the project implementation approach.

A critical role of executive leadership is sending a clear message that this is important and providing unwavering support as the project evolves. Medical leadership must likewise demonstrate commitment and communicate a clear sense of direction, and they must support involvement of a cross-section of attending physicians in the process prior to implementation to ensure attention to the operational realities of CPOE.

One of the best analyses in the literature describes the initial failure of an attempted CPOE implementation effort at the University of Virginia.[8] The author attributes the failure to lack of involvement of a "group of clinically respected

internal advocates within the attending physician population;" inadequate anticipation of the behavioral changes required; and poor expectations management. Conversely, in major success stories, physician executives lead the effort, with physician champions and thought leaders involved in all aspects, from system development or selection to planning phase-in across the organization. [7, 14, 15]

Tips On Leadership For Successful Implementation:

- Visibly link CPOE to strategy in terms the hospital community can understand;
- Position CPOE within a culture of quality improvement;
- Assign the Chief Executive Officer and/or the Chief Medical Officer a formal active role in the project;
- Integrate CPOE with Quality and Patient Safety;
- Adopt new CPOE processes as medical policy;
- Measure and celebrate progress and success.

Sponsors. Executive sponsorship and a committed clinical champion are absolute requirements for success. The champion's standing as a well-respected, active clinician is far more important than any experience with, and knowledge of, IS. In fact, a physician champion who is viewed as overly computer-literate (and, therefore, with skills and interest in technology well beyond those of his/her peers) can be a disadvantage. Standing within the medical staff is critical to the individual's commanding the respect and trust of the organization's key opinion leader physicians. In addition, this person's responsibility for the effort must be part of his/her job description, with accountability and time formally allocated to playing this role.

Ideally, there should be more than one project sponsor; others should be individuals representing key areas that will be affected by the implementation of CPOE: nursing, pharmacy, radiology, etc.

Tips regarding sponsors:

- Recruit an internal physician leader with "a fire in the belly" to improve quality;
- Have the physician champion for CPOE report to the CMO;
- Commit other clinician resources to support the effort and pay them for their time;
- Create a formal partnership between the physician leader for CPOE and IS.

Operations and technology. There must be an obsession with the details of process before, during and after implementation. Lack of fit with clinical process and practice has been the downfall of a number of CPOE efforts because physicians understandably resist process changes that produce inefficiencies and complicate their work, without providing clear benefits.
End-user involvement in design, implementation, and support of the system

is essential to ensure deployment of applications that will fit clinical workflow – which generally must be redesigned in tandem. Physicians must participate at some level in user interface design or review, as physicians must agree that they will be able to do their work online.

For technology, there are several clear requirements:

- Design the user interface to be fairly consistent across modules, to simplify use and minimize the need for training;
- Ensure that systems are fast, preferably displaying sub-second response time;
- Also ensure that systems are highly reliable and available round-the-clock, seven days a week;
- Provide adequate workstations (or other user order entry devices), located to permit convenient use in physician lounges, on-call rooms, and clinics, as well as in work areas on the inpatient units. Mobile devices have been well received in several implementations.

For community practice physicians, workflow includes the reality that they often need to write patient orders from their practice site or other remote location. Remote access to the CPOE system can greatly improve use. Internet technologies can facilitate such remote access.

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Requirements for data integration across systems can represent a significant challenge. Frequently the databases containing patient-specific data critical to providing the highest value functions of CPOE – data on laboratory results, pharmacy, and vital signs such as weight – are independent of the CPOE product. The data must be imported through real-time interfaces, and data definitions must be standardized sufficiently to permit use with a rules engine or other decision support logic.

Tips for selecting CPOE products:

- Use scenarios involving complex orders and typical routine in evaluating software fit with workflow and impact on physician time;
- Look for vendor reference sites with a similar environment and objectives;
- Be sure software can support your quality improvement agenda (e.g., medication error reduction targets, guideline adherence targets).

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Finally, the task of defining the clinical decision support "rules" to be used by the system to determine when to issue alerts – for potential interactions between drugs and allergies or drugs and laboratory values, for example – is the responsibility of the implementing organization. Some vendor products may contain "starter sets" of rules, but these invariably need to be reviewed and adapted to the local environment. In many cases, these will need to be designed from the ground up to gain the support of the medical staff.

Workflow and change management. Policies and procedures for both implementation and ongoing operations must be defined in advance of rollout. There must be a commitment to planning for, and supporting, significant workflow/process changes that affect all caregivers and ancillary departments – not just the physicians. Workflow changes must be planned carefully to address multiple operational transitions during a CPOE rollout:

- As each care environment goes from paper to CPOE;
- As patients are transferred from CPOE-supported units to non-CPOE units;
- As providers go from CPOE-supported units to non-CPOE units;
- As CPOE implementation is extended from medicine to surgery or other settings;
- As ancillary departments migrate from paper-based orders to electronic orders.

Because CPOE is phased in – on individual services or units – workflow is a moving target that requires careful management and attention to detail as each new area is supported by the system. Issues are different on medical from on

surgical units, and each phase of implementation raises new challenges that require prompt attention.

A carefully thought-out, detailed, well-documented implementation plan to guide the effort must be communicated to all affected parties, and a committed implementation team employed to convert care settings consistently throughout the rollout process. One of the surprises often encountered during implementation is the lack of standardization in procedures from one nursing unit to the next and among clinical services. Identifying these variations and coming up with standards for terminology and procedures turns out to be a very time-consuming and challenging task.

Tips For Workflow and Change Management:

- Set up pilots to test the new CPOE-enabled process and the approach to supporting rollout;
- Pause after the pilot and plan to regroup to analyze results and revise process redesign, technology and/or implementation approach, as needed;
- Expect and be prepared to respond to surprises;
- Focus on the process of care, not just the orders;
- Be sure all the disciplines and ancillary departments are at the table.

Even when things go well, there is typically a need for push, rather than voluntary adoption of CPOE. In one national survey, 70 percent of hospitals with CPOE software available were not requiring or encouraging its use. As a result, more than one-half reported 10 percent or less of their physicians were using the system, and 58 percent reported that 10 percent or less of the orders were being processed. [12]

Training, support, and maintenance. It is not a coincidence that the great majority of hospitals that use CPOE are academic teaching centers, in which residents are the primary physician users of the order entry system.

In such settings, physicians-in-training learn to use the system and can assist one another and teach new residents. In addition, since this "captive" group writes most or all orders, training and education can be effectively targeted toward them, and compliance more easily achieved and monitored.

The training process should reflect the actual tools and processes used in the care setting, and training for clinicians should be offered by clinicians (frequently nurses). System design should be such that use is nearly self-evident, requiring only basic orientation. Training time, especially for physicians, is ideally kept to a minimum, with coaches available during the first few days and weeks (at all hours) to provide

Tips For Training:

- Minimize formal training/maximize personal coaching on initial rollout;
- Train on actual screens and workflow;
- Use clinicians as coaches/trainers;
- Incorporate CPOE process in new staff orientation and training.

assistance as needed. It may be helpful to have support staff spend designated amounts of time observing users at workstations, to understand common use patterns and questions. User support (help desk, etc.) must be available round-the-clock, within minutes; a few failures in this department can go a long way toward setting back or even killing a system implementation. In addition, system changes in response to problems must be made within hours, or users will not trust IS to meet their needs and will begin to find ways to work around the system, thwarting successful implementation. Support and system redesign must be ongoing; the task of implementation is never complete. It should be easy for users to offer feedback on system features, for example, by email to a common mailbox. Finally, a group of users must convene regularly to address problems that arise over time and that cross departmental boundaries; such a group should include members of all affected patient care and ancillary departments.

The bottom line. In conclusion, perhaps the single most important take-home lesson from industry experience is the following: Implementing inpatient CPOE involves a great deal of change, and there must be wide agreement within the institution that the effort is of strategic importance and commitment to see it through. There must be both unified executive support and in-depth end-user – especially physician – involvement and leadership for CPOE to succeed. Success requires changing clinical process and practice, which in turn require addressing a myriad of details concerning how work actually gets done and being flexible and responsive to issues identified during rollout. The information systems department does not drive the successful CPOE initiative – executives and physician users do.

Chapter Four

What Lessons Can Be Learned from the Pioneers?

Overview - The following case studies briefly describe the environment, challenges, key successes, and lessons learned from organizations that have successfully implemented CPOE. Although early implementations of inpatient CPOE were mostly in teaching hospitals, success stories are now starting to emerge in other environments. The case studies that follow were selected to include a variety of settings and both homegrown and commercial systems.

Looking across the case examples, a number of themes clearly emerge:

- Close ties between the organization's strategic plan and the CPOE project;
- Focus on implementing people and process changes needed to support improved patient care, rather than on implementing a new computer system;
- Strong physician leadership and communication in all aspects of the project;
- Flexibility and willingness on the part of the vendor and Information Services to customize the system extensively.

The discussion below attempts to highlight other lessons from these efforts that will be of use to others.

Queen's Medical Center — Honolulu, HI

Case Study Highlights

- This large community hospital successfully engaged private community physicians in performing order entry for their hospitalized patients;
- CPOE was implemented as part of a larger effort to build the infrastructure for institutional momentum to improve clinical practice and process;
- Six physicians, paid to support improvement committees as clinical information leaders, were accountable for improvement results.

The Queen's Medical Center (QMC) is the largest tertiary community hospital in Hawaii. The CPR initiative at QMC is an improvement-focused process that includes three major components:

The Patient Management System – consists of an inpatient order entry and results reporting system, an ambulatory electronic medical record, and a home care

Affiliated community physicians are engaged in entering inpatient orders as part of an institutional clinical effort.

system. The inpatient Eclipsys 7000 System (called "CLiQ" for Clinical Information at Queen's) was implemented beginning in 1995, currently supports inpatient order entry and results reporting, and is available on 400 workstations in QMC and 45 private physician offices on and off the Honolulu campus. In addition, the Queen's Health System is implementing an ambulatory medical record system (Logician from MedicaLogic) and a home care system (PtCT Home Care) to round out operational patient management;

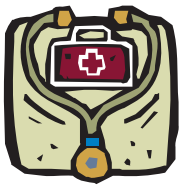
The Population Management System – clinical data from CLiQ are combined with demographic and financial data in the Eclipsys Enterprise Data Warehouse (EDW) and are used in conjunction with the Explore benchmarking database to support iterative clinical performance improvement;

The Performance Improvement Organization – a staff of clinicians and data specialists who are superusers of the CPR system and serve as internal consultants to clinical departments in their clinical improvement efforts.

QMC approached order entry as one tool in its overall effort to continuously apply quality improvement to clinician decisions and processes. CLiQ currently processes 40,000 orders per week; most community physicians who admit to QMC now enter orders into CLiQ and obtain patient information by consulting the system. A variety of clinical decision support methods, often in combination, are integrated into order screens and screen flow. These provide advice on clinical considerations and cost, alerts and warnings; display patient information relevant to the order; suggest best practices through order sets and pathways; and facilitate access to electronic knowledge bases. The strategy is to inform, encourage or require desired behavior from clinicians. During the first three years, this approach has achieved performance improvement successes that rival those of expert systems from large academic medical centers and involve affiliated, independent physicians in direct order entry. Plans for continued improvement to CLiQ include upgrades to the user interface, increased order entry functionality, enhanced clinical decision support with a rules engine, and multidisciplinary clinical documentation.

Central to realizing the objectives for CLiQ in improving clinical decision-making was involving the community physicians who admit to the hospital as active system users. Specific goals and objectives set for CLiQ measured the level of involvement as one indicator of success. Queen's Medical Center won the Davies CPR Recognition Award in 1999.[15] In their remarks at the symposium, project team members highlighted the importance of tackling physician order entry from within an improvement culture. Improvement was the agenda, with specific quality objectives driving the effort, and project leadership and structure linked to performance improvement, operational processes, and IS in a unified management approach. The institution has achieved what it set out to do: shift from opinion-based clinical decision-making to evidence-based decision-making. Evidence for this transformation includes a backlog of new CLiQ-enabled practice improvements suggested by the clinical staff.

Other lessons learned include the following:



- Queen's made a large investment in the people aspects of the project. Specifics included good leadership, well-orchestrated communication, a well-organized effort with a clear focus on meaningful and measurable improvement and aggressive project management;
- Six physician clinical information leaders were accountable for specific tasks and deliverables leading to physician use. These individuals worked more than two years on a part-time basis and were paid for their time;
- Although POE was "voluntary," the importance of compliance was reinforced by pulling order sheets from patient charts two weeks after POE went live. Physicians were assisted in developing personal orders sets during implementation, but the clinical departments have all migrated to departmental order sets, as the medical staff is now comfortable with POE and pushing to reduce unnecessary variation;
- Be "fleet of foot" in responding to issues and in identifying ways to add value for physicians;
- During vendor selection, Queen's had set its sights on a more powerful order-entry application, including a rules engine. Since there were no acceptable candidates on the market, QMC initially went with a less powerful tool as an interim measure. The institution has gained much value from leveraging all of the available decision support in the initial tool and has really established quality improvement as a driving force in the institution.

Sarasota Memorial Health System – Sarasota, FL

Case Study Highlights

- Significant cost savings and qualitative benefits were achieved as a direct result of this initiative;
- Using the "Shock to the Future" approach, changes involving physical environment, process, and technology were done in concert, with care delivery as the overall focus;
- Clinician-led project management approach was key to gaining physicians' acceptance;
- Changes are not immediate and resistance should be expected. Staff need ongoing training to assimilate changes to the care delivery process.

Sarasota Memorial is a community non-teaching hospital with 845 beds and 240,000 outpatient and ER visits annually. Starting in 1994, Sarasota Memorial identified an electronic patient record (EPR) as a key project to support its strategic

Large community hospital study says physician use of clinical information system can save as much as 10 percent of the physician-controlled variable costs associated with patient care.

plan initiative to develop an integrated care delivery system. Part of the EPR would be a computerized physician ordering system. But the hospital's clinicians believed strongly that the success of the initiative would be to continually reinforce the message that "technology does not improve patient care – the redesign of the care workflow does." This philosophy, which puts care delivery first and technology second in a supporting role, helped Sarasota successfully create a redesigned care delivery process that has demonstrated significant results. Examples of how this philosophy was put into practice include:

- Clinician-led project team with Information Systems (IS) support. Typically, the reverse is followed, where IS leads the project and has supporting Physician and Nursing committees;
- "Shock to the Future" implementation approach. This approach encompassed a physical redesign of the patient care units to accommodate the process and technology changes brought about by the project. This approach balanced "high tech" with "high touch." Sarasota saw the redesign as necessary to create an environment where caring and computers were totally compatible, thus eliminating one more barrier to using the computers;
- Continuous physician education that Sarasota coined as "Adopt a Doc." Nurses provided round-the-clock assistance to physicians new to learning the system to help change ordering patterns and minimize resistance.

The original system from HealthVISION was first piloted in a 15-bed medical/surgical unit in 1997 as a "proof of concept." However, several factors have slowed the project's progress. Physician training and acceptance of the new system into the care delivery workflow took much longer than originally anticipated. A stalled laboratory system implementation delayed progress by several months. At the same time, Eclipsys purchased HealthVISION. Eclipsys took the HealthVISION functionality and added it to its Sunrise® Clinical Manager system, and this new system was installed at Sarasota. This all took time and delayed the rollout. The rollout was completed recently throughout the patient care areas. In May, a total of 338 physicians, out of a medical staff of 640, accessed the system from on campus, home and the office. This constituted more than 80 percent of the admitting physicians. They placed orders that account for about 28 percent of all orders placed in the system. Approximately 170 physicians routinely access the system remotely via the Internet. These numbers are expected to increase over time. Functionality supported by this new system includes order-entry/results retrieval, patient charting, checking for duplicate orders, computerized physician order templates, and rules-based clinical decision support. Currently, Sarasota has built 35 alerts. Remote access and wireless laptops are recent innovations increasing acceptance by adapting to the way physicians work, i.e.,

providing access to automation wherever physicians are working, as opposed to making them change their workflow and come to the automation.

Extrapolating, this represents approximately 10 percent of the total hospital budget for one year. This study analyzed 2,256 cases during a six-month period in 1999 and identified cost savings in the form of decreased utilization of resources Other known savings not yet quantified include reduced staff time for order entry, documentation and chart auditing. The hospital concludes that physician use of an automated resource management tool has a major impact on a hospital's bottom line because physicians control a high percentage of variable costs.

A 1999 Study Identified Significant Cost Savings, Which Sarasota Directly Attributes To This Project, Including:

- 8.4 percent decrease in utilization costs per admission;
- 6.8 percent decrease in LOS per admission;
- 62 percent decrease in laboratory test turnaround time. [17]

The project has realized several qualitative benefits, including improved chart accuracy and access, enhanced data security and increased physician, patient, and staff satisfaction. Although not measured, the hospital also believes that medication errors are reduced due to increased legibility of orders and reduced duplication of tests. Sarasota is continuing to make enhancements to the system and provide more patient care information electronically to the clinicians. They see this as one very important step toward their original 1994 goal – an electronic patient record.

Montefiore Medical Center – New York, NY

Case Study Highlights

- Inpatient units using CPOE have 100 percent online ordering by either residents or attending physicians;
- CPOE can be very successful but takes a long time to make the transition. Implementation in phases can bring early wins and start to demonstrate benefits;
- Success requires physician champions, physician involvement in the design and implementation, and ongoing support to build on new functionality;
- Constant communication and responsiveness to feedback are critical for success. Multi-year projects easily can lose support and momentum if progress is not communicated effectively.

Montefiore Medical Center is a large academic medical center with 1,200 inpatient beds and 40 ambulatory centers. For Montefiore, the quest for a Clinical Information System (CIS) that supported Physician Order Entry started more than 10 years ago. The goal then, as it is now, was to improve the quality of patient care and reduce medication errors by getting the physicians in front of better information at the time of ordering. Unfortunately, financial issues and state project approval slowed the process for years. However, in 1994 Montefiore resumed the CIS selection project with a project team of more than 25 people, including 12 physicians. The team focused on both inpatient and outpatient ordering requirements, reviewed commercially available systems and selected the Phamis LastWord system (now IDX LastWord).

Montefiore uses a phased approach to build a successful CPOE.

Montefiore decided to take a phased implementation approach to build a solid clinical information database before installing CPOE. The first phase included patient registration, laboratory and radiology results reporting, and pharmacy profiles. This phase was implemented throughout the organization in March 1997. Physicians were now able to view order results and medication information online. Montefiore believed that this clinical information was the "carrot" the physicians needed to move to the next phase that included CPOE.

Physician participation was critical in the second phase of the CIS project. Several dedicated some of their time to the system's design. Separate physician groups were established to address the design requirements for front-end or end-user view, laboratory ordering, radiology ordering, pharmacy ordering and automated rules and alerts. Once the initial designs were done, there were physician retreats to test workflows and information flows using different patient scenarios. Designs were refined, and then select high-priority system enhancements were made by the vendor. It was this level of involvement, commitment and communication that helped physicians understand what they would be gaining from using the system.

Implementation of this phase started in March 1999 and as of June 2000 had been rolled out to 350 inpatient beds. For these units there has been a 100 percent transition from paper order forms to online physician order entry for all types of orders. To ease the transition, Montefiore has offered two technology-based incentives. The first is the ability to access patient information outside the main campus, typically from the physician's home. The other is the use of wireless laptops that allow physicians the flexibility to enter orders while they round or after rounds are completed. Both have been very successful and widely used. They expect to continue to roll out the system to all inpatient settings with an additional 400 beds by the end of the year. After the inpatient units are done, the ambulatory centers will follow. An important lesson learned from this implementation is to listen constantly and respond to feedback. Even after the system has been installed, Montefiore holds ad hoc feedback sessions to learn about how the system is being used and what can be done to improve acceptance and use.

With 30 percent of the inpatient units now using CPOE, Montefiore has started to measure the impact of the system from both a cost and quality perspective. Both initiatives are under way.

The Ohio State University Medical Center – Columbus, OH

Case Study Highlights

- An internal study of the pilot clearly identified measurable time and cost savings attributable to the implementation of the CPOE. This facilitated moving forward with the effort;
- Physician involvement is critical to success. By using existing clinical councils and policy groups, OSUMC was able to maximize physician support and buy-in. Other success factors included financial compensation for physicians involved in system design and demonstrating quick response and follow-through for physician decisions;
- CPOE installation should be rapid and completely replace the old system to focus on the future and not compare the new with the old;
- CPOE requires very site-specific information for clinical guidelines, protocols and alerts. It is important to look for vendor products with tools that allow authorized end users to update this information on an ongoing basis rather than requiring IS staff or the vendor to do so.

The Ohio State University Medical Center (OSUMC) is an academic medical center with 553 staffed beds and more than 300,000 outpatient visits a year. In 1993, the medical center leadership developed a strategic plan that focused on quality, cost, outcomes measurement and primary care network development. The supporting Information Systems plan identified the need for a comprehensive computerized patient record (CPR) that included a computerized physician order entry system. In 1994, OSUMC realized that the systems currently in place could not meet the requirements of a CPR and began an evaluation and selection project with a team staffed with physicians, non-physician caregivers and administrators. Care Center of Shared Medical Systems (SMS) was selected to provide patient registration, clinical data reporting, and computerized physician order entry.

One hundred percent physician online ordering is demonstrated at a large academic medical center, using physician-driven design and structured rollout approach.

Physician support and leadership were seen as integral parts of the initiative's success. This led to the creation of the Physician Consulting Group, an 11-member physician work group that represented a wide range of specialties. They were charged with designing the CPR prototype with the expectation that involvement at the design level would translate into greater physician acceptance. The group met two to three times a week to work out the detailed system design, document needed policy changes, and spearhead physician buy-in for the implementation process in the form of education and issue resolution. Physician-to-physician information exchange and education has been a tremendous plus for the project.

Already in place at OSUMC is a very successful clinical leadership council formed to coordinate activities related to enhancing high-quality care, patient satisfaction, outcomes, and value, while providing the basis for "best practices." Known as the Leadership Council for Clinical Value Enhancement and supported by four policy groups, this clinical leadership structure provided the medical knowledge and support for several key components of the CPOE:

- Clinical practice guidelines;
- Order sets based on the guidelines;
- Rules in the form of reminders and alerts;
- Patient education documents.

The System Was Piloted On A Surgical Transplant Inpatient Unit In February 1998. Key Findings Based On The Pilot Were:

- Patient care order communication was much more efficient so that interventions began immediately;
- The fact that orders can be placed and viewed anywhere expedited care delivery;
- Overall turnaround time from the time the order is placed until the order is implemented was greatly reduced, resulting in lower LOS and thus lower costs. Key cost-related statistics included:
  - * Two-day decrease in LOS per admission;
  - * Two-hour decrease in turnaround time for pharmacy orders;
  - * $910 decrease in pharmacy charges per admission;
  - * Standard order sets assist clinicians in adhering to standards of care and preventing errors of omission, both of which positively impact the cost of treating patients.

Working in unison, the physician consulting and policy groups, Information Services and the vendor designed and customized the system to support the streamlined physician ordering requirements, embedding clinical guidelines, alerts and protocols. Through the creation of more than 400 order sets, virtually every order possible has been pre-identified and pre-loaded into the system. New orders are added for a patient through a simple and very fast "point and click" process, eliminating the need to type except for the entry of comments. The addition of wireless technology that allows physicians to enter orders online from the patient's bedside using a dedicated laptop computer increased the speed and accuracy of order completion, benefiting both patients and physicians.

The pilot was shut down temporarily due to resource shortages and a need to focus on Y2K. Problems and deficiencies identified during the pilot were addressed and, in February 2000, an updated system was installed in the same pilot site. In April, the

system was implemented successfully in the medical center's cancer hospital. The flagship hospital (400 beds) went live in May. All sites using the system have 100 percent physician order entry, with approximately 95 percent of the orders entered by residents and the remaining orders entered by the attending physicians. A study is under way to analyze the effect of the system on the number of medication errors and adverse drug events.

The Rehabilitation Institute of Chicago – Chicago, IL

Case Study Highlights:

- RIC has been using CPOE successfully for more than 10 years in all inpatient and outpatient locations;
- CPOE can save physician time when structured ordering and order sets are implemented;
- Involving physicians is critical to success. RIC has a very strong Provider Advisory Committee, which steered the functional design and communicated progress.

The Rehabilitation Institute of Chicago (RIC) is a 155-bed inpatient facility with multiple outpatient clinics throughout metropolitan Chicago. RIC provides a wide range of rehabilitation services, including acute programs, outpatient services and a variety of support, research and educational programs. Computerized physician order entry was implemented more than 10 years ago using the Technicon Data Systems (TDS) order entry/results reporting system. Using this system, physicians entered all patient orders, diagnosis information and allergies. Internal studies done in the early years of the implementation have indicated that medication errors decreased with the implementation of the CPOE. An added benefit noted by the physicians using the system is the administrative time savings. Specifically, the use of order sets and structured orders has reduced order entry time and ensures that all required information is recorded. Nursing and the ancillary areas no longer need to call the physician to ask about missing or illegible order information.

The Rehabilitation Institute follows a "Big Bang" implementation approach for computerized physician order entry at all inpatient and outpatient care delivery sites.

RIC now has replaced the original TDS system with a new Meditech client/server system. One challenge was the familiarity with the older application and the inclination to duplicate the old system's functionality and use rather than take full advantage of the features of the new one. Additionally, the physicians had a long list of additional functions that they wanted the new system to address. The project team followed a very logical approach to

address the functionality issues. Each request was documented in terms of its impact on patient care, the work effort to complete, financial implications and impact on the implementation date. The Provider Advisory Committee, made up of attending physicians, residents, and nurse practitioners, reviewed the requests and made the final decisions on what functionality needed to be included and in what priority order.

There were three user committees initially organized for the system design – allied health, medical and nursing. This structure led to issues relating to common vocabularies and abbreviations, ordering standards, and system requirements. Taking members from each user committee, RIC set up an integrated care planning group. This group addressed the standards and requirements issues and then reported the results back to the user groups, which completed the more detailed work on process and functions.

On the technology side, Information Services faced the challenge of moving from a mainframe architecture to a new client/server networked system configuration. RIC was the alpha site for the new Meditech client/server version of the system, so there were software problems that the team and the vendor worked through to solve. In total, the CPOE replacement project took two years to complete and was implemented across inpatient and all outpatient locations on Sept. 1, 1999.

Regenstrief Institute for Health Care – Indianapolis, IN

Case Study Highlights

- CPOE, part of a homegrown clinical system, provided some of the first research evidence that computerizing physician ordering can reduce costs;
- Rapid prototyping, heavy user involvement, and unwavering executive support over many years are all viewed as critical to success;
- Regenstrief is known for its deep experience with clinical decision support and for institutionalizing processes for physician feedback.

Regenstrief Institute designs, builds and maintains clinical databases and applications for four hospitals on the Indiana University Medical Center campus and a number of physician practices throughout the city of Indianapolis. Led by practicing physicians who work in the venues in which the systems are used, the effort has spanned the last 28 years, producing pioneering work in clinical decision support applied to both ambulatory and inpatient care. The Regenstrief

Institute was the first to study computer-based patient record systems in a randomized trial and accounts for a large share of published studies in this area. System efforts now extend beyond the campus to include the Indianapolis Network for Emerging and Primary Care, linking the 11 major hospitals with ERs, 55 pharmacies and 30 distributed ambulatory care sites.

Work on the Regenstrief Medical Record System started in 1972, and was initially focused on the capture and integrated display of patient data. Once a critical mass of structured data was available, work began on the development of automatic reminders and decision aids, first for ambulatory care and then for inpatient care. In targeting physician entry, orders rather than notes were targeted because orders have more obvious structure (making computer entry easier) and offer more opportunities for shaping practice patterns through computer feedback. As is the practice when any RMRS application is developed or enhanced, rapid prototyping with continual user feedback was used to incorporate user experience with integrating order entry into routine tasks. This requires periodically pulling back and redesigning screen or workflow, when users indicate that the initial approach is inadequate. When the order entry system was initially deployed, users provided clear feedback that the original design for constructing order instructions – using the multiple-field approach – was much too cumbersome. The system was removed from use and a better solution was rapidly implemented and installed. Evolution of the order entry interface has now incorporated hundreds of changes, most of them stimulated by user feedback.

Rapid prototyping and an active role for physician users in reviewing interface design and clinical decision support contribute to successful implementation of a homegrown physician order entry application. CPOE has been shown to reduce utilization and patient charges by more than 12 percent.

Decision support incorporated into order entry includes order sets, passive disease or symptom-based choice lists, comments embedded in choice lists with links to reference materials, dynamically constructed choice lists, counter-detailing messages, cost data, past results data relevant to the order, blocking rules (to redirect ordering intent), consequent orders and guidelines/suggested orders. Some of the principles used to guide design of decision support are that reminders must be actionable, pithy or concise, patient-and task-specific, available at the time of care, constructed to make the task easier, reasonable at least one third of the time and appropriate to the available data.

Both formal and informal processes result in new decision support logic. Users are encouraged to submit suggestions for new rules and enhancements to existing ones, each of which is reviewed for feasibility. Departmental and Institutional Committees, such as the Pharmacy and Therapeutics Committee and the Respiratory Care Committee, also develop new rules on an ongoing basis. All rules are carefully evaluated and tested. As an example, Dr. Clem McDonald, the lead developer, often tells the story of a patient in an ICU on

DNR status, for which the system prompted a physician to order a mammogram. The Computer-Based Record Institute (CPRI) recognized the Regenstrief Institute in 1997 for its accomplishments in building an integrated inpatient and outpatient medical record and improving care through clinical decision support.[14]

In their remarks at the symposium and application essay, the developers attributed their overall success to a combination of executive support across the institutions they serve; to a teaching, research, and public service mission; and to careful analysis and improvement of care processes, technical excellence, and responsiveness to user needs. The physician development team published some of the earliest research validating the effects of inpatient CPOE on resource utilization. In a randomized controlled clinical trial, they examined the charges

Physician Developers Who Have Consistently Managed The Effort Speak Often At Professional Meetings About Their Experience and Lessons Learned. The Following Points Pertaining To Order Entry Come From Panel Discussions At Several Such Meetings:

- Institutionalize mechanisms for user feedback. Physicians are more tolerant of less than perfection if someone is listening and they see results. Regenstrief holds weekly user feedback meetings, which are open to any users. Users can also submit questions or suggestions via e-mail. They track and respond to every complaint;
- "Pizza is the grease that makes order entry work." User feedback meetings are pizza lunches, and Regenstrief's pizza budget is impressive. Other tips: Surgeons eat the most (plan on one pizza per physician) and users are happier if they can e-mail ahead their requests for anchovies, M&Ms® or other goodies on their pizza;
- Work on enhancements and refinements is a task that is never done;
- Response time is the design requirement for clinical users. A one-quarter-second response time is the target; keep the focus on this issue by displaying the elapsed time on the screen;
- Power users should not be the focus of design. Any user should not ever have to guess how to do something, where to go next, or how to get out of the function in which he or she is working;
- To increase physician acceptance, apply the "mall/superstore" principle. At Regenstrief, users can examine satellite weather photos, cartoons, general information and full-text medical books and journals online;
- One of the most popular features is a rounds report, a printed summary of orders, diagnostic tests and other patient status information, which can be folded to pocket size.

for each admission and for specific categories of orders. The physician teams using CPOE generated charges that were 12.7 percent lower; bed charges, diagnostic test charges and drug charges were also reduced. Reductions of similar proportion were found for hospital costs, and the mean length of stay was 0.89 days shorter. [6]

Brigham and Women's Hospital – Boston, MA

Case Study Highlights

- BWH has provided much of the research evidence demonstrating the power of computerizing physician ordering;
- The homegrown CPOE was designed to require only orientation-style training, but nurse coaches were available on nursing units as the system was rolled out;
- Different types of clinical decision support are designed into the system to improve clinical practice and speed physician entry time.

Brigham and Women's Hospital (BWH) in Boston is a 720-bed urban teaching hospital with a set of integrated clinical applications and implementation experience, which has provided much of the research on the power of physician order entry to avoid adverse order-related events and improve overall quality of care. [7]

Clinical decision support is a core component of the CPOE, part of a conscious effort to intervene at the point of care during the ordering process in a number of ways:

- Provide extra information to the orderer (e.g., dose-related test results);
- Prevent adverse events (20 times a day an order is written that is contraindicated because of patient allergy; 400 orders each day are changed in response to a computerized alert or warning);
- Suggest better care processes;
- Standardize when desirable (e.g., by suggesting dose and frequency for a medication order);
- Enable more cost-effective care (e.g., by suggesting a lower-cost medication of equal efficacy).

One of the early homegrown order entry systems provides a lot of lessons about interface and application design features that facilitate acceptance and quality improvement and a coaching model for implementation. Advanced decision support incorporated in CPOE has enabled impressive quality gains and cost savings through drug substitution, improved dosing and more appropriate utilization of diagnostic and treatment interventions.

Decision support incorporated into the ordering process includes order sets and templates, specially designed screens for every type of order (medication, blood products, etc.), extensive use of defaults based on a study of 300,000 orders, automatic displays of relevant patient information and alerts, warnings and other ordering suggestions. [7, 16]

One of the major challenges of CPOE is capturing structured orders without adding to the time taken by the manual order writing process. CPOE was designed to include several different modes for physician ordering: assisted mode (prompts for required fields) and quick mode (free-text order interpreted into a standard order). The latter feature, which was thought to be critical for physician acceptance, is actually used a very small percentage of the time (about 8 percent of all orders). Most physicians prefer orders sets or templates (35 percent of all orders). Although CPOE is not time neutral, many of the design features combine to keep additional time to a minimum.

CPOE rollout was very carefully orchestrated and included pilots, pauses and efforts to minimize dual processes. The system was designed to require only orientation-style training, and clinician coaches (mostly nurses) were stationed in clinical areas for a period of weeks as each clinical area went live. Users also received a lot of attention after rollout – retraining, coaching and proactive feedback loops leading to fixes. Managers of the rollout effort have estimated that for each $1 spent in developing the system, a $2 to $3 investment is required to ensure a successful implementation. Physician leaders of system development also believe that tailoring the system to accommodate the differing information flows of different clinical situations was critical to integrating CPOE into the work processes of every unit and clinical service.

The BWH has an active program in health services research and epidemiology. From the beginning of the CPOE effort, researchers have published extensively on successes with achieving benefits of CPOE: reducing adverse events, reducing costs of care, reducing unnecessary variation, reducing response times to address changes in patient status and rapid ability to influence clinical practice when new information alters the standard for care.[1] In recognition of this work, the BWH received the Davies Recognition Award in 1996. [7] Their research also figured prominently in the recent IOM book on patient safety.[1] The following are selected examples:[7]

- Drug-allergy warnings are followed 70 percent of the time, thereby avoiding an estimated $250,000 in costs of avoided adverse events per year;
- Prompts guiding physicians toward a change to more cost-effective dosing of one medication (ondansetron) led to a 92 percent switch to recommended dosing and a $500,000 savings in charges per year;

- Prompts addressing excessive use of another medication (human growth hormone) by providing guidance and requiring documentation of reason for use reduced ordering by 85 percent and related charges by $177,000 per year;
- Introduction of alerts on highly abnormal laboratory results (panic values) has reduced median time to respond with changes in orders from 2.1 hours to 0.7 hours.

Physician developers of the system have shared the following additional lessons learned about clinical decision support in frequent publications and presentations:

- Knowing when and who to notify is one of the complex challenges of making event engines work. One of the keys to success at the BWH turned out to be the Coverage List, which keeps track of which patients are under the care of which provider (necessary to know who needs to be alerted and how they can be contacted, who is managing results, who needs to be contacted about/sign off on discharge). This is especially complicated in a teaching environment because coverage responsibilities shift every few hours;
- The BWH monitors physician acceptance of system advice and finds a high degree of acceptance. A requirement for success is a high rate of relevance of prompts and alerts generated to the clinical situation the physician is facing;
- Rules in the rules engine are very tightly managed by domain knowledge committees and several levels of review. This structure is important because it slows down the process, allowing plenty of time to check validity, gain buy-in and inform physicians in advance via e-mail.

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Appendix A:

Key Features of CPOE to Gain Benefits of Reduced Medication Errors, Reduced Costs, and Improved Quality

CPOE Functionality	Benefit Opportunities		
	Reduce Medication Errors	Reduced Costs (independent of reducing medication errors)	Reduce Variation/ Improve Quality
Basic Ordering			
*Structured orders: route, dose, frequency, duration; choice lists and templates	●		●
*Allow input of patient height and weight	●		
Standard order sets and ordering regimens	●	●	●
Linked to patient problem list	●		●
Dosing recommendations	●		
Linked to clinical pathways	●	●	
Disposition of orders based on user defined rules	●		●
Link to knowledge databases (e.g., Medline)	●	●	●
Remote access	●		
Basic Checking/Alerts			
Duplicate therapy checking	●	●	●
*Drug-drug interaction checking	●		
*Drug-allergy interaction checking	●		
*Drug-lab interaction checking	●		
*Check against hospital formulary		●	
Expiring orders alerts	●		
*Exception documentation for alert overrides	●		
Advanced Ordering			
Specialized protocol ordering, e.g., chemotherapy (includes: dose, frequency, route; duration all in compliance with protocol)	●		●
Order prompting and alerts using an industry standard rules engine	●	●	●
Mobile access	●	●	●
Advanced Checking			
*Check dose against age, weight, or BSA	●		
*Check dose against renal function	●		
Drug-disease interaction checking	●		
Check against health plan formulary	●	●	
Check for corollary orders for adjunct drugs and tests	●		
Check for corresponding monitoring order/secondary order	●		●
Alerts with "built in" options to facilitate response	●		●

*Denotes critical features.

Appendix B:

Order Entry Systems – Major Functions and Features

Ordering Functionality	Sophistication of System
	Order Communication – Primarily focused on capture and transmission of orders
Order type	Ancillary tests only (e.g., Laboratory, Radiology, EKG)
Order entry features	Single order Order sets Structured orders Cascading orders (order explosions) Verbal orders Series orders/recurring Create a charge Print a requisition Print an order Enter a patient charge Enter a non-patient chargeable work order Support verified and unverified orders
Proactive functions and decision support	
Order status	Automatic D/C of orders when a patient is discharged
Order signing capabilities	
Order display option	Single order display
End users supported	Nursing and/or support staff
Interfaces needed	Online real-time interface message to ancillary system
Security options	Single sign-on to application Location-specific security
Advanced Technology functions supported	

Sophistication of System	
Order Entry – Designed for use by physicians and other caregivers and incorporating more interactive clinical decision support	**Order Management – Incorporating more advanced features, including clinical decision support**
Nursing and other caregiver orders Links to nursing task management	Benefits-based orders using an industry standard rules engine
Standard order sets and ordering regimens-personalized order sets Pending orders Hold and resume orders Fill-in-the-blank orders in order sets Future orders/conditional orders Add-on orders Linked to inpatient cross-disciplinary clinical pathways Complex medication orders Complex administration times and dosages Comments and annotations Orders linked to hospital formulary Departmental functionality for OT/PT/RT/etc. Capture patient height and weight	Orders linked to a problem list Orders linked to referral management rules Orders linked to payer-specific formularies Dosing recommendations TPN ordering Linked to cross-continuum, cross-disciplinary clinical pathways Merged pathways Link to scheduling—Scheduling (automated) Disease management algorithms Voice recognition Order permissions for pharmacists Detail order permissions for MDs Specialized protocol ordering
Duplicate therapy checking Drug-drug, drug-allergy, drug-lab checking Medication order warning—against patient weight or BSA Health maintenance alerts Expiring orders alerts (meds only) Pending/outstanding order alerts Exception documentation for alert overrrides	Order prompting and alerts using an industry standard rules engine Check dose against renal functions Check for corollary orders for adjunct drugs and tests Check for corresponding monitoring orders/ secondary order Drug-disease checking Outstanding order alerts Alerts with-built in options to facilitate response Order notification via pager
Closed loop. Automatic updates on order status Automatic D/C of orders when a patient is transferred to another area (e.g., the OR) Audit trails	Disposition of orders based on user-defined rules
Electronic signature Counter signature	
Multiple order display by order type	
Nurses and physicians, physician extenders, other providers	Nurses and physicians, physician extenders, other providers
Online real-time interface message from an ancillary system – two-way interface Handheld device download	Linkages to knowledge databases (e.g., Medline)
Sensitive patient-level security	Sensitive test level security
Test-level screen customization Bar coding of orders Printing of prescriptions	Remote access Mobile access via radio frequency laptops and handhelds Remote prescription printing

Appendix C:

Vendor Information

Vendor Name/ Corporate Address	Product Name(s)	Contact Information
Cerner Corporation 2800 Rock Creek Pkwy. Kansas City, MO 64117	CareNet OM, ProVide, Discern Rules, Documentation Management	Phone: (816) 201-3806 Fax: (816) 201-7369 Carrie Gard-Jacobsen, Senior Applications Specialist Web site: www.cerner.com Email: info@cerner.com
Clintelligent/CliniComp 9655 Towne Center Drive San Diego, CA 92121	CliniComp Order Management	Phone: (800) 350-8202 Fax: (858) 546-1801 Alan Portela, Vice President of Sales and Marketing Web site: www.clinicomp.com Email: info@clinicomp.com
Eclipsys Corporation 777 E. Atlantic Ave., Suite 200 Delray Beach, FL 33483	Sunrise product line – Knowledge Based Order Communications	Phone: (561) 243-1440 Fax: (561) 243-8850 Bob Robbins, Vice President, Consulting Relations and National Accounts Web site: www.eclipsys.com Email: info@eclipsys.com
IDX Systems Corporation 1400 Shelbourne Road Burlington, VT 05402	IDX LastWord	Phone: (802) 862-1022 Fax: (802) 862-9591 Dr. Graham Hughes, CPOE Product Director Phone: (206) 689-0944 Web site: www.idx.com Email: info@idx.com
McKessonHBOC 5995 Windward Pkwy. Alpharetta, GA 300054184	Pathways Coordinated Care, HNS, Care Manager 6.2, Star 17.1, Alerts, Medication, Order Entry, Orders and Guidelines	Phone: (404) 338-6000 Corporate Office Fax: (404) 338-6101 Jim Webb, Vice President, Clinical Product Marketing (800) 752-4143 Boulder Office Web site: www.hboc.com
Meditech Meditech Circle Westwood, MA 02090	Order Entry Physician Order Entry	Phone: (781) 821-3000 Fax: (781) 812-2199 Dr. Richard Pope, POE Product Manager Alan Goldstein, Product Development Web site: www.meditech.com Email: info@meditech.com
SMS Corporation 51 Valley Stream Pkwy. Malvern, PA 19355-1406	Invision – Order Processing Module, Physician View, Rules Engine	Phone: (610) 219-6300 Fax: (610) 219-3274 Dr. Floyd Eisenberg, Physician Consultant Web site: www.smed.com Email: Dr.Eisenberg@smed.com
3M Health Information Systems 575 W. Murray Blvd. Murray, UT 84157	Stockell Order – Communication Product	Phone: (801) 265-4200 Melinda Costen, Marketing Manager for Care Innovations Unit Web site: www.3mhis.com Email: crose@mmm.com