CPOE Systems: Success Factors and Implementation Issues

ABSTRACT

The medication error dilemma has come to the forefront of most hospitals’ improvement agendas. The most often cited solution to the problem has been computerized provider order entry (CPOE) systems. These systems have significant potential to improve errors associated with illegibility as well as inappropriate drug use and dosing. On the other hand, CPOE system implementation is fraught with barriers that impede acceptance and use of these systems. Knowing what strategies have proven successful and what upfront analysis is required can help increase the chances of success and ultimately improve the quality of patient care.

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Healthcare workers on the front lines of patient care delivery were probably not as shocked as the general public when the Institute of Medicine (IOM) report, “To Err is Human” (Kohn, Corrigan, and Donaldson, 1999), came out. It made public the fact that healthcare workers make mistakes, and to a significant degree. This eye-opening document has resulted in unequalled public insistence for change. Medication errors top the list of mistakes that increase morbidity and mortality in hospitalized patients. The literature related to medication errors in terms of patient outcomes and financial ramifications is startling. One solution to this particular problem is for hospitals to implement a CPOE system. Some authors and researchers document very positive outcomes, while others are still wary about its ability to solve the entire medication error problem.
Installation of CPOE systems in hospitals nationally has been described as slow. Several reasons have been noted for the delayed penetration of this technology. High cost and complexity of the task top the list of these reasons. Strategies that have resulted in successful implementations as well as lessons learned have been published in increasing numbers. This paper reviews the literature associated with medication errors, and then analyzes the barriers to CPOE implementation. Strategies for successful implementations proposed by various authors will then be reviewed along with a discussion of the complexity of these substantial projects.

Medical Mistakes

The landmark document, published by the IOM, “To Err is Human” (Kohn and others, 1999), was the impetus for action that brought patient safety and error reduction to the forefront of many healthcare improvement agendas. It points out that literature on medical errors has not been plentiful, but has increased over the past several years. The report contains data from several studies that have been cited numerous times in subsequent healthcare literature (Armstrong and Chrischilles, 2000; Business Roundtable Press Release, 2000; Chaiken, 2001; Clark, 2001; First Consulting Group, 2000; The Institute for Safe Medication Practice (ISMP), 2000; Jeck, 2001; McConnell, 2001; Millennium Health Imperative, 2001; The National Academy of Sciences, 2001; Simpson, 2000). Two of these often cited studies are the Harvard Medical Practice Study and a similar study of adverse events in two hospitals in Colorado and Utah. The Harvard Medical Practice Study found that adverse events occurred in 3.7 percent of the hospitalizations, with 58 percent of those attributable to preventable adverse events with 13.6 percent of these adverse events leading to death. In the Colorado and Utah study, adverse events took place in 2.9 percent of hospitalizations with 53 percent attributable to preventable errors and 8.8 percent leading to death (Kohn and others, 1999). When these numbers were extrapolated to the more than 33.6 million admissions in U.S. hospitals in 1997, it implies that at least 44,000 and perhaps as many as 98,000 people die in hospitals annually as a result of medical errors.

The IOM document alone is more than likely responsible for the majority of the increased efforts surrounding medical error reduction in the United States. Government agencies and task forces have sprung up to answer the call for improvement. The Institute for Safe Medication Practices (ISMP), a nonprofit organization that works closely with the healthcare industry to provide education regarding adverse drug events, supports the IOM report and encourages the use of a national adverse drug event (ADE) reporting system (ISMP, 2000). The Joint Commission for the Accreditation of Healthcare Organizations (JCAHO) added new patient safety standards beginning July 2001, which include enhanced error reporting, designation of qualified individuals to lead the safety improvement effort, and the development of risk identification and reduction programs (JCAHO, 2001a, 2001b). The Medicare Payment Advisory Commission’s report to Congress recognizes the medical error problem and has made recommendations for congressional action (Medicare Payment Advisory Committee, 1999). The Leapfrog Group, made up of a group of influential healthcare purchasers, has also been active in education and support of patient safety issues (The Leapfrog Group, n.d.).

Medication Errors

Unfortunately, medication errors are not uncommon in hospitals. There is much literature documenting their incidence. The largest numbers of serious errors in hospitals involve medications (Thomas and others, 1999). In a nine-year study conducted at a teaching hospital, Lesar, Briceland, and Stein (1997) reported that the most common types of medication errors were errors that involved prescribing medications to which the patient was allergic and prescribing inappropriate dosage forms. Lesar, Lomaestro, and Pohl (1997) reported that hospitalized patients experienced an overall rate of medication errors of 3.99 errors per 1,000 medication orders. Classen, Pestonik, Evans, and Burke (1997) reported that adverse drug events increased hospital length of stay by 1.74 days, while in another study by Bates, Spell and Cullen (1997), it was estimated that preventable adverse drug events increased length of stay by 4.6 days.

When evaluating the financial ramifications of medication errors, Schneider, Gift, Lee Rothermich and Sill (1995) estimated costs of medication-related problems at a university hospital as being $1.5 million in a year. Another study at two large teaching hospitals discovered that 2 percent of admissions experienced a preventable ADE, resulting in an average increase in hospital costs of $4,700 per admission or about $2.8 million annually for a 700-bed hospital (Bates and others, 1997). Drug related morbidity and mortality was estimated to cost $76.6 billion in the ambulatory setting in the United States (Johnson and Bootman, 1995). Although
the numbers vary, the literature consistently demonstrates that medication errors are costly and occurring at an alarming rate.

The CPOE Solution

Solutions to this problem have been offered by many authors, but the resounding theme is the use of technology and the application of computerized provider order entry (CPOE) systems (Armstrong, 2000; Armstrong and Chrischilles, 2000; Bates and others, 1998; Chaiken, 2001; Dwyer, 1997; First Consulting Group, 2000; General Atlantic Partners, 2001; Hume, 1999; Jech, 2001; The Leapfrog Group; McConnell, 2001; Millennium Health Imperative, 2001; The National Academies Press Release, 2001; Simpson, 2000; Teich and others, 2000).

In a report written for the American Hospital Association, Armstrong (2000) defines CPOE as “a system for direct entry of one or more types of medical orders by a physician into a system that transmits those orders electronically to the appropriate department” (p. 6). Many CPOE systems include alerts, drug information, access to evidence-based clinical guidelines and some degree of decision-support functionality. Since clinicians other than physicians have the authority to write orders, all types of practitioners should be considered when referring to CPOE (Chaiken, 2001; Simpson, 2000).

Electronic ordering of medications as a solution to the error problem seems to make sense given that medication errors are reported to be the largest cause of adverse hospital events (Thomas, 1999, Simpson, 2000). A study by Bates, Spell, and Cullen (1997) found that ordering is the largest source of medication-related error and that computerized ordering reduced these errors. Teich and others (2000), in a study of hospitalized patients, found that 56 percent of preventable adverse drug events were primarily related to errors in prescribing. These studies conclude that the implementation of a CPOE system has the potential to significantly reduce medication errors.

One of the early users of CPOE has estimated that these systems could potentially save an organization between $5 million and $10 million annually in medication costs by guiding physicians to effective lower doses or alternative medications and reducing adverse events through decision support tools (Teich and others, 2000). Other research has shown reduced use of resources, reduced length of stay, and an overall reduction of costs with CPOE (Tierney and Miller, 1993).

Order-entry systems can also be a powerful tool for reducing unnecessary variation in care by encouraging recommended practices through the use of online guidelines or pathways (Teich and others, 1996). In another study by Teich and others (2000), it was reported that the tools included in these systems reduced errors associated with inappropriate medication selection, inappropriate dosing for several drugs, and inappropriate frequency of medication administration. Bates and others (1998) concluded that, in their institution during a six-month study period, CPOE decreased the rate of non-intercepted serious medication errors by more than half, although this decrease was larger for potential ADEs than for errors that actually resulted in an ADE.

The potential benefits of these computerized order-entry systems range from legible orders, a non-trivial issue, and completeness of orders, to alerts of possible contraindications based on unique patient information.

Common order entry errors can be reduced, such as (a) selecting the wrong drug for a solution; (b) selecting the wrong dose, route, interval or duration; (c) overlooking drug allergies; (d) overlooking drug-drug interactions; (e) overlooking drug-laboratory value interactions; and (f) overlooking drug-disease interactions. To sum it all up, order-entry systems tout the ability to create a legible, complete order and apply logic-based rules to patient information to prevent errors. Studies that evaluate the effectiveness of CPOE systems are generally positive and show results that CPOE systems do result in a reduction of medication errors. At the same time, most do include the fact that this strategy alone will not be the complete panacea.

Will CPOE Be Enough?

In December 2000, the United States Pharmacopoeia (USP) released the “Summary of 1999 Information Submitted to MedMARx™, A National Database for Hospital Medication Error Reporting.” This report indicated that the three most frequently reported types of medication errors were (a) omission errors (failure to administer an ordered medication dose); (b) improper dose/quantity error (any medication dose, strength, or quantity that differs from that prescribed); and (c) unauthorized drug errors (the medication dispensed and/or administered was not authorized by the prescriber, which includes wrong drug errors) (USP, 2000, ANA News 2000). This differs from the earlier studies that concluded the ordering/transcribing phase was most problematic.
The five phases of the medication management process have been identified as ordering, dispensing, administering, documenting, and monitoring, each with the potential for error commission or omission (ANA News, 2000). When CPOE systems are analyzed based on these phases, it becomes clear that these systems will be primarily effective in the ordering phase, but not as beneficial in other phases.

While it is obvious that a CPOE system would assist in reducing errors related to illegibility and inappropriate drug use and dosing, it does not address the aspects of medication use that involve the dispensing, administering, documenting, and evaluating the effectiveness of the drug.

A feature article on the MEDerrors.com (2000) Web site is quick to point out that CPOE systems lacking drug information and access to patient data and rules have the potential to be more error prone. They argue for the implementation of safety measures beyond CPOE. While supporting the use of CPOE systems, First Consulting Group (2000) suggests that hospitals could attempt several alternatives, instead of the costly and complex CPOE solution. They suggest process changes and related interventions that have been shown to reduce errors such as (a) improving policies and procedures for medication history taking; (b) creating preprinted standing orders for common conditions; (c) establishing protocols for high-risk medications (anticoagulants, insulin, etc.); (d) including pharmacists in unit rounds, especially in ICUs; and (e) standardizing infusion devices across care units. While the Institute for Safe Medical Practice (n.d.) also encourages the use of CPOE systems, it notes there are other activities that must occur concurrently for more global error reduction.

Research mentioned earlier by Teich and others (2000) touts CPOE as being a powerful and effective tool for medication error reduction. In the same article, there is mention that CPOE is not the complete solution. In their research, they noted that physicians would often reject guidelines for appropriate drug use if they did not agree. The Agency for Healthcare Research and Quality (2001) offers a combined approach to error reduction including root cause analysis, CPOE with decision support, automated medication dispensing systems, patient wrist-band bar coding technology, aviation style preoperative checklists, and integrating human factors theory into the design of medical devices and alarms.

The respected author and researcher Lucian Leape has been a driving force in medical error reduction. He recognizes that CPOE alone will not be adequate. He states that if an organization is serious about preventing errors, the problem must be attacked on three levels simultaneously: (a) culture change that allows for risk-free reporting of errors by employees, (b) the use of technology and CPOE systems, and (c) smaller incremental changes. These smaller changes can take the form of having a pharmacist on each nursing unit, removing potassium chloride from the unit shelves, and initiating pre-printed orders for high-risk situations, such as chemotherapy (Hume, 1999).

As shown in table 1, various improvement strategies will assist in the reduction of medication errors at different phases of the medication management process.

The overall opinion from the literature is that CPOE systems do significantly reduce medication errors, but not all of them.

### Overcoming Barriers to Implementing CPOE

The statistics in the literature are somewhat disappoint-

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*Table 1. Medication Safety Improvements: Effect on Medication Management Phase*
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Implementing CPOE is admittedly costly because it involves the complexity of the entire task. The literature, discussing possible rationale for low use, identifies several factors. For many years, hospital executives and most vendors of hospital information systems believed that physicians would not use CPOE. Another reason for slow adoption is that demand has been low, and has resulted in minimal motivation for development on the part of the vendor community. Those systems that were available were perceived as less than adequate. This appears to be changing as demand and interest increase (McConnell, 2001; First Consulting Group, 2000).

Ferren (2001) reports that physicians at a Pennsylvania hospital, where CPOE was recently implemented, were reluctant to embrace the technology for a number of reasons. The reason most commonly stated was that of fear of using the system. Some physicians claimed that their handwriting was perfect and illegibility was not an issue. Others held the belief that handwritten orders were faster to execute and that computerized order entry would be more cumbersome.

The costs surrounding an implementation of this type of system are extremely high and would be a significant capital investment. Brigham and Women’s Hospital, one of the pioneers of CPOE, has estimated the cost of developing and implementing such a system in 1992 at $1.9 million, with ongoing maintenance costs of $500,000 per year. Purchasing and implementing large vendor-developed systems today can vary greatly in cost, but could be in the tens of millions of dollars (Kaushal and Bates, n.d.). Government support is improving and taking the form of grant money. U.S. Sens. Bob Graham and Olympia Snowe introduced legislation that would establish a 10-year, $1-billion hospital and skilled nursing facility grant program to offset the prohibitively high cost of developing and implementing CPOE systems (Lovern, 2001).

Probably the largest reason for the slow implementation of CPOE systems is the complexity of the entire task. Implementing CPOE is admittedly costly because it involves infrastructure, hardware, software, and considerable process redesign and change management (Chaiken, 2001). First Consulting Group (2000, p. 4) states, “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.” It is apparent from the literature that there is not one foolproof recipe for a successful CPOE implementation; however, there are many authors who offer their advice based on experience. The following sections will discuss a number of factors that have reportedly led to successful implementations of CPOE systems.

Continuous Administrative Support

Support for the project at the executive level is a necessary prerequisite, even prior to considering this huge undertaking. Not only is there a need for support at the initial stages, but it is required on an ongoing basis (Ferren, 2001). Management has a responsibility to develop a clear vision of CPOE and address such issues as (a) why do we wish to pursue this, (b) what do we expect to get out of it, and (c) how will we measure success.

Ahmad and others (2002) reported several strategies for success as a result of their nine-month pilot study at Ohio State University. Hospital administrators realized the importance of having physicians involved. They recruited and funded a physician team to lead this project. These physicians were required to sign a contract outlining their responsibilities. With strong backing from physician leadership and administration, numerous efforts to standardize practices and policies across the organization became an integral part of the CPOE project. For example, only electronic ordering was allowed. Administration and physicians backed this policy.

Once implemented, ongoing CPOE support is reported to be crucial for success. The administrative team should embrace the philosophy of continued support and provide adequate funds to ensure that help is always available. When Ohio State University Health System implemented its CPOE system, administration created permanent support positions that remained on-site from 6 a.m. to 11 p.m., seven days a week. These support personnel wore red tunics and were dubbed the “red coats” (Ahmad and others, 2002).
During implementation of CPOE at Abington Memorial Hospital in Pennsylvania, a group of super-users were trained and placed on each unit. They wore identifying buttons that read, “TDS Super User – May I Help You?” They were trained to approach physicians and ask if they could help them with the system. They distributed a User Tips Booklet and ensured that the phone number for the help desk was prominently displayed (Ferren, 2001).

Several authors note that a CPOE system rollout is a significant milestone, but only the beginning of intensive support. Providing this assistance on a continuous basis will have a strong bearing on the system’s success or failure. Planting a seed and neglecting to water or fertilize it will ultimately lead to a weak and unhealthy plant. The analogy can be made to implementing CPOE and not providing strong ongoing administrative support at all levels and from all departments involved.

**Physician Empowerment and Involvement**

Physician involvement, in combination with administrative support, tops the list for the most cited reason for success. In fact, it was noted in one article that a failed CPOE implementation was the result of not having adequate physician representation on the implementation team. It is recommended that a physician champion be committed to this project’s efforts who is a trusted, clinically active, well-respected physician (First Consulting Group, 2000).

Successful implementations in the literature describe a physician team that is intimately involved with all steps of the system’s implementation. At one hospital, a Physician Advisory Group was charged with the oversight of all clinical aspects of CPOE implementation. This group comprised the department chairs from general medicine, internal medicine, pulmonary medicine, urology, and surgery (Ferren, 2001). Representation from such a wide range of departments led to a powerful support base for CPOE.

Physician buy-in, involvement, and championship are common themes in the literature that are reported to result in successful CPOE implementations. The message to hospital administrators contemplating acquisition of a CPOE system is clear — plan on making a resource commitment toward physician involvement.

**An Effective Implementation Team**

In addition to administrative and physician support, the implementation team should represent the organization at various levels and from various departments. Departments impacted by CPOE should play a role in the implementation of the system. Because CPOE has such far-reaching effects, the task of determining who should be on the team can be somewhat difficult. Most teams are made up of a core group of administrators, physicians, nurses, and information services staff, with ancillary department involvement as needed. The team could potentially be too large to be effective or too small to garner adequate support if all departments are not included. Team composition is very important and unique to each institution. The task of team selection should not be taken lightly.

**Analysis and Considerations Prior to Implementation**

The preceding sections have emphasized the importance of human resources required to undertake this important project. For an implementation to be successful, these dedicated resources will be involved in an extensive amount of upfront work that includes system analysis, integration between ancillary systems, work process analysis and redesign, and review of organizational culture. Upfront analysis is as imperative as effective project leadership.

This somewhat abstract, seemingly interminable task is probably the most difficult of all phases of the project. Yet without thorough consideration and detail given to this task, CPOE implementation could be fraught with obstacles and frustrations. It is, in the author’s opinion, one of the least understood and poorly documented components of the CPOE implementation puzzle. Several articles have stated that CPOE is not solely a technological solution to the medication error problem. They emphasize that it involves much more than computer technology and, if there is not adequate support to work through the organizational culture and dynamics surrounding the implementation of CPOE, it may result in failure (Kaushal and Bates, n.d.).

An important task for the implementation team will be to assess and analyze current processes and determine how these will be affected by CPOE. Eisenburg and Barbell (n.d.) have broken down the physician order entry workflow into eight steps, (1) access the system, (2) select a patient, (3) review patient data, (4) enter data, (5) sign/confirm order, (6) order is processed, (7) receive results/take action, and (8) outcomes and accountability are measured.

Each of these steps will be affected by the implementation of CPOE and could benefit from evaluation. For example, a hospital’s current process for the first step of access-
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The complexity of CPOE implementation has spawned a group that calls itself the Physician Order Entry Team (POET). POET is based in the Division of Medical Informatics and Outcomes Research at Oregon Health and Science University. It consists of representatives from a variety of healthcare-related disciplines. Membership of the team varies over time, but all members use research methods that consist of cross-site comparisons using multiple qualitative and quantitative data-gathering techniques to assess implementation issues regarding CPOE. POET is funded by grants from the National Library of Medicine, the U.S. Department of Energy, and other resources (Physician Order Entry Team, 2002).

In May 2001, at a retreat center called Menucha, 13 CPOE experts met with seven members of POET for the purpose of developing recommendations for CPOE implementation. The Menucha Consensus Conference succeeded in its goals of identifying and agreeing on a list of considerations and questions organizations may choose to work through to increase their potential for an implementation of CPOE that is judged to be successful. A list of 10 high-level considerations was generated to benefit organizations thinking about implementing CPOE (The 2001 Menucha Conference List, 2002). Discussion and analysis of some of the highlights of these considerations follow this list:

1. Motivation for Implementing POE
2. Foundations Needed Prior to Implementing POE
3. Costs
4. Integration/Workflow/Health Care Processes
5. Value to Users/Decision Support Systems
6. Vision/Leadership/People
7. Technical Considerations
8. Management of Project or Program/Strategies/Processes from Concept to Implementation
9. Training/Support/Help at the Elbow
10. Learning/Evaluation/Improvement

Motivating factors for implementing CPOE at the organization level need to be identified and agreed upon. A general consensus among stakeholders of why CPOE is being pursued should be the impetus for moving forward with CPOE implementation. Is there pressure from administrators, clinicians, and/or regulatory agencies, or is there pressure to improve efficiency? The development of the mission and vision statements for this project will stem from the motivation to proceed and begin to build a relationship among implementation team members.

Another consideration is questioning whether there exists a strong foundation prior to implementation that includes adequate resources in terms of people and finances. This foundation relies upon an administration that is trusted and is an advocate for change and embraces continuous learning. Because of the high costs associated with CPOE, organizations need to have a long-term financial plan and understand the total costs of CPOE. Organizations must ask themselves, “Can we afford a temporary loss of productivity?” as is often seen during the period of time just after implementation.

Hospitals are advised by the Menucha group to give thought to their organization-wide change strategy as they consider CPOE. Because it is a given that work processes will change, a plan to analyze and work through these changes is necessary. Response times, ordering times, and communication times all need to be reviewed in terms of what effect CPOE will bring. How will retrieval of information occur and how will this affect integration with other systems? A plan for organizational readiness for CPOE that key stakeholders mutually agree upon is strongly advised.

The value that CPOE will provide to clinicians is another consideration that should be discussed prior to implementation. Analyzing this concept will assist organizations in promoting and marketing the system. Will the proposed system include decision support, order sets, and alerts? Will efficiency and patient care be improved? In other words, what’s in it for the individual physicians and practitioners using the system, and how will it benefit their practice?

One of the primary technological considerations that should be addressed is the security plan. It is recommended that security of access and confidentiality issues be carefully planned, especially with impending enforcement of the Health Insurance Portability and Accountability Act (HIPAA). Advantages and disadvantages of a single sign-on need consideration.

In addition, organizations should assess the ability to and the desire to customize the CPOE system. It is advisable to determine if a system administrator will be able to perform customizations or whether the vendor will need to perform this task, and for what fee. Other technical questions to consider include: (a) How will data integrity be ensured? (b) How will the system interact with current systems? (c) Will remote access be needed and is the network infrastructure stable? (d) Is there an easy way to exit the system for frustrated users? (e) Is there a consistent and friendly graphic user interface?
Project management strategies to consider include overall impact of changing workflow processes. Managing people issues will come into play and should be addressed. The project manager will need to ensure that plans are detailed enough – but not too detailed. It is recommended that there is not exaggerated attention to details that would jeopardize the overall implementation goal. Keep it simple; strive for excellence, not perfection. Are there clear and measurable goals with a clear communication plan?

Considerations for training and support include the concept of “help at the elbow.” This means ongoing, readily available help. What will be the training methodology employed (one-on-one, group sessions, train the trainer, etc.)? A formalized training program is the normal process that occurs from two to four weeks prior to “go live” of the system. However, getting busy physicians to attend training can be difficult. One organization dealt with this by having the chairperson of its Patient Safety Committee send a letter to all division chiefs. Letters were also sent to all targeted physicians. The trainers followed up with non-responders with three personal phone calls. If these follow-up calls did not result in attendance at a training session, the chairperson of the Patient Safety Committee was notified. This very respected and persuasive leader then made a personal call to the physician. This strategy was reported as being very effective (Ferren, 2001). In addition to initial training efforts, the plan for ongoing education and competency assessment should be addressed.

The final consideration involves the methodology for system evaluation and testing. Consider carefully planning a process for problem identification and problem resolution involving the users. How will you continuously improve the system? Understand that you are never done. This is truly an iterative process.

In a qualitative study by Ash and others (2002), a Multiple Perspective Model was used for organizing the descriptions of CPOE by physicians, administrators, and information technology staff. This was done to aid in the understanding of all points of view of CPOE. Discussion comments regarding CPOE were organized into the categories of technical, organizational, and personal systems. Notes from 120 person-hours of observation and audiotapes from 22 hours of formal interview and focus groups were transcribed and resulted in more than 400 pages of transcripts. The results demonstrated the unique differences of perspective of CPOE among the three groups. While physicians were more clinically oriented, administrators were more fiscally focused. Information technology personnel tended to focus on the complexities of system integration and the frustrations with vendors for not producing a perfect product. The point the author makes is that it is imperative that those implementing CPOE understand all views and plan implementation strategies with this in mind (Ash, Gorman, Lavelle, and Lyman, 2000). Given the large number of factors to consider prior to implementation of CPOE, it is not a wonder that it takes organizations years to implement such systems.

**Conclusion**

Medication errors in hospitals are significant in volume, contribute to the morbidity and mortality of patients, and increase resource utilization and costs. The CPOE solution, while costly and complex, is one way healthcare organizations can reduce a significant amount of medication errors. To be on the realistic side, however, organizations should be aware that CPOE systems will not solve the entire medication error problem. This becomes evident as one examines the medication management process in conjunction with the functionality of CPOE systems.

Several reasons are cited for organizational delay in implementing CPOE systems. Complexity of the task and high costs are common factors, while other reasons include lack of physician acceptance and inadequate development of the product by vendors. The work of process re-engineering adds to the hesitancy to move forward with CPOE implementation. Despite these barriers, there have been successful implementations documented at many facilities. These organizations attribute their success to factors such as ongoing administrative support, physician involvement, an effective implementation team, and substantial planning.

Ongoing research conducted in hospital settings with differing characteristics is recommended. Success stories and lessons learned from experienced institutions should be shared and ideas incorporated into vendor products and in organizational implementation plans. As more organizations move forward with CPOE systems, there will be a broader knowledge base from which to draw. Continued publication of the CPOE implementation experience will assist organizations contemplating what seems to be an enormous undertaking, but one that is well worth the effort in terms of making improvements to the care and safety of our patients.

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