

PRIORITIZING CAPITAL ALLOCATION FOR PATIENT SAFETY





Prioritizing Capital Allocation for Patient Safety

**How healthcare leaders can evaluate
information technology
using evidence-based information**

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EXECUTIVE SUMMARY

Interest in the use of information technology to address medication error has never been greater. Computerized physician order entry (CPOE) systems and barcode-enabled point-of-care (BPOC) technology are the forerunners of this movement, and experts are predicting a rapid deployment of both CPOE and BPOC systems throughout the nation's hospitals. A recent leadership survey conducted by the Healthcare Information Management System Society reports that 42 percent of hospital chief information officer respondents named BPOC to be a top IT priority for the next two years.¹ As hospitals assess their investments in technology and evaluate available alternatives, there is an emerging trend toward BPOC as an affordable and achievable solution for reducing errors.

The ideal solution to preventing medication error includes a full gamut of technologies that provide quality and safety checks throughout the medication delivery process. The challenge becomes selecting the technology in which to invest limited capital and human resources first. The pressure to act is mounting as public awareness and concern for patient safety grow. Investing in those solutions that are affordable and achievable and that protect the investment in existing information technology provides the best return on a patient safety investment, and positions the organization as a safety leader in the marketplace.

Healthcare organizations are in agreement that medication error represents one of the most pervasive, preventable, and costly sources of patient harm.² Evidence supports BPOC as the logical first step for a hospital to immediately address preventable medication error. The important criteria

Core Messages

- BPOC is more effective, faster to implement, and less expensive than CPOE.
- BPOC is able to get the attention of your community, as it directly interacts with the patient.
- Clinicians benefit from BPOC use, aiding retention.
- Hospitals that adopt BPOC will have a competitive advantage over others in the market.

by which hospitals should evaluate which patient system to deploy first are risk of implementation, cost, and implementation time frame. While CPOE implementations have proven to be high risk, extremely expensive, and lengthy in duration, BPOC system implementations are low risk, significantly less expensive, and quickly implemented. BPOC can be implemented in as little as six months, while CPOE projects have taken several years. Because of the massive process change involved and the disinclination of both hospitals and software vendors to accommodate the change, many CPOE implementations have fallen short of their desired outcome.

Even more importantly, the evidence clearly indicates that BPOC technology is inherently more effective at intercepting medication errors than CPOE. While early adopters of BPOC systems are reporting a reduction in reported medication errors of 70 to 86 percent, those deploying CPOE report reductions of

about 55 percent in reported medication errors. The BPOC system’s greater impact is a result of safety checks positioned at the end of the medication delivery process—the patient bedside. This is the only step in the current medication delivery model that doesn’t have a second checkpoint and is the most logical place to first deploy a safety check. BPOC not only catches errors at administration of the drug, but also catches a number of upstream errors originating in the ordering, transcribing, and dispensing of medications. CPOE’s check at the beginning of the process cannot intercept downstream errors, which account for more than half of all medication errors. Sophisticated BPOC systems also include the ability to provide additional safety checks for blood transfusions and laboratory specimen draws.

Because BPOC costs significantly less and is more effective at reducing medication errors, the return on investment for BPOC technology is much higher than CPOE. An analysis shows that the payback period for BPOC can be under two years, while the payback period for CPOE is 10 years or more.

The value of being perceived by healthcare consumers as the leading provider in the community on matters of patient safety cannot be overstated. Equally important to the considerations above is the highly visible market impact of BPOC. Because of the widespread use of technology in society, consumers expect to see technology when they seek healthcare. Patients may not witness the use of CPOE systems for order entry, but they are certain to interact with BPOC technology several times daily when a nurse scans the patient’s wristband and medications at the bedside. As retail consumers, patients intuitively understand that bar codes are more accurate than humans. Nursing

retention and recruiting are of the utmost importance, and BPOC systems have been shown to increase nursing satisfaction. Providing this tool for nursing staff is a competitive advantage for recruiting and retaining this scarce resource.

Similar to bar-code use in retail applications, BPOC systems are also able to accurately capture point-of-care charge transactions in real time to help streamline the billing process. The BPOC infrastructure can be used to capture charges for medications, supplies, and other clinical services such as respiratory therapy treatments. Accurate real-time data can be instrumental in updating medication and supply inventories for improved materials and supply chain management.

Comparison of CPOE to BPOC Based on a 500-bed hospital		
	CPOE	BPOC
Implementation cost	\$7.9 million	\$1.9 million
Ongoing annual cost	\$1.3 million	\$180,000
Implementation time	3+ years	6 months
Implementation risk	high	low
Payback period	10+ years	< 2 years

Hospitals that are first to introduce bar-code scanners to their patients will gain significant advantage over their competitors. BPOC systems provide patients with a high level of confidence in the organization’s commitment to safety and are an influential factor in determining where patients will go for future healthcare. Once patients experience BPOC, they will accept nothing less. All hospitals will eventually use bar-code technology to safeguard and automate bedside care; a hospital’s strength in its market is contingent on whether it chooses to lead or to follow.

THE SOLUTION CONTINUUM

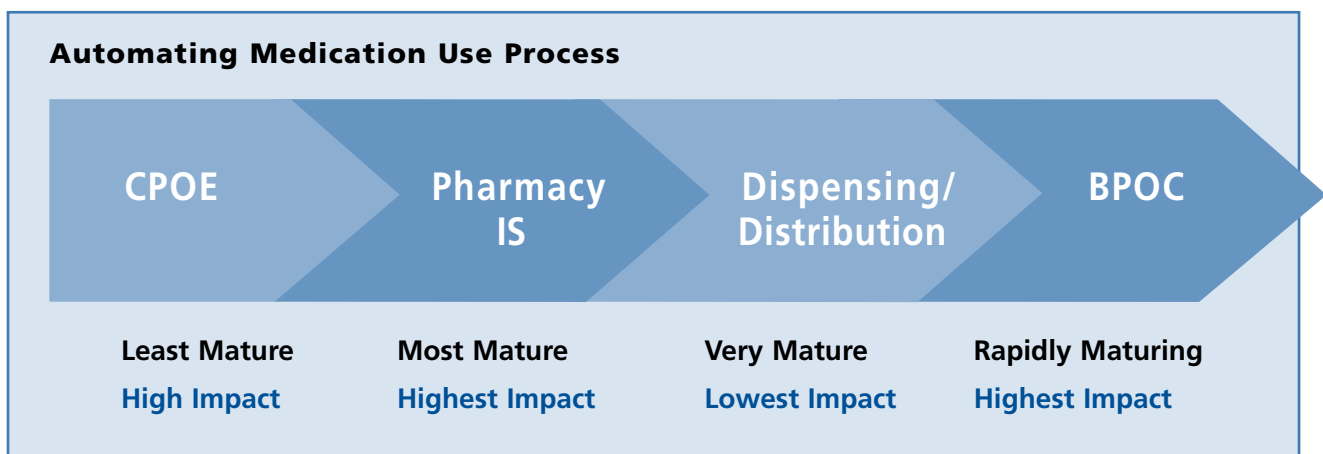
More than half of hospital leaders surveyed perceive patient safety as their top priority,³ but find themselves in the unenviable position of steering their organization through uncharted waters. The challenge now facing these leaders is not *if* to invest in patient safety, but rather *where* to first invest limited capital to get the most effective return in reducing errors.

Hospitals may elect to use a full arsenal of various information system technologies for medication error reduction. Realistically, the major solutions boil down to CPOE at the front end, pharmacy information systems and automated dispensing cabinets throughout the dispensing process, and BPOC technology at the point of care. In practice, nearly all hospitals have a pharmacy information system in place, and most use some level of decentralized automated dispensing cabinets. Dispensing cabinet vendors have even designed IT enhancements to their cabinets for improved medication safety. However, safety through positive patient identification and medication verification is

effective only if assured at the patient's bedside, not while nurses are removing medications from the cabinet. Thus, the current challenge is to evaluate CPOE and BPOC technologies, which have the highest impact on patient safety. What are the determining factors in making capital allocation decisions? [See table below.]

To evaluate adequately the potential of capital allocations, hospital executives can use corporate finance-based allocation practices that require quantification of return on investment as well as evidence of other qualitative returns for all potential projects. A thorough understanding of costs, resource demands, and the complexity and risk of implementation enables hospitals with limited resources to confidently acquire the most effective technology.

A comparison of data published on CPOE and BPOC systems demonstrates the effectiveness of this allocation approach.



WHERE DO ERRORS OCCUR?

The medication use process may involve dozens of individuals and as many as 60 steps from the time the physician prescribes a medication until the patient receives it.⁴ The process can be broken into four major components: ordering, transcribing, preparing or dispensing, and administering.

In 1995 Leape and colleagues described the origin of hospital medication errors in the following manner: 39 percent occur when a physician orders a medication, 12 percent occur when the medication order is transcribed and sent to the pharmacy, 11 percent occur when the medication order is processed in the pharmacy, and 38 percent occur when the nurse administers the medication to a patient.⁵ By this account, eliminating errors at either the point of ordering or at the point of administration would be of roughly equal value to overall error reduction.

However, the researchers also reported an often overlooked but critical element for those evaluating the impact of CPOE versus BPOC technology—error interception rates at each stage. According to Leape and his associates, “Nearly half of all [ordering] errors were intercepted by nurses and by pharmacists. About a third of transcription and dispensing errors were intercepted—again, largely by nurses prior to administration.”⁶ In contrast, only 2 percent of errors that originate during medication administration at the patient’s bedside are prevented, as

there is no second set of eyes or double-check routinely in place.⁷

A recalculation of medication errors that factors in error interception rates reveals that more than half (51 percent) of medication errors that reach the patient occur during the administration stage as compared to only 22 percent that originate at physician ordering. These data offer a reminder that only at the point of care can medication errors of any type become potential adverse drug events. For previous stages in the medication process there are checkpoint redundancies to help identify and correct upstream errors.

Logically, hospitals are focusing on the first and last stages of the medication use process—when the medication is prescribed and when it is administered to the patient. But the question remains whether to implement a CPOE system to address the blunt end of the medication use process or a BPOC system to intercept errors at the sharp end—where errors translate to patient harm.⁸ The answer lies in the empirical and experiential evidence on record.

	Prescribing	Transcribing	Dispensing	Administering
Medication phase error distribution	39%	12%	11%	38%
Per 100 errors	39	12	11	38
Intercept rate	48%	33%	34%	2%
Number of errors reaching patient	20	8	7	37
True error rate	22%	11%	10%	51%

Adapted from Leape et al., 1995, and California Healthcare Foundation, 2001.

ERROR REDUCTION POTENTIAL

Primary to any buying decision is the issue of product effectiveness—does the product do what it is intended to do? One means of analyzing the effectiveness of various systems is to conduct a search for experiential reports. While these reports reflect varying research methods that rarely provide apples-to-apples comparison, they do offer evidence of the relative error reduction potential of BPOC and CPOE systems.

Evidence of CPOE Error Reduction

“Automated approaches that would address the greatest number of problems identified [with CPOE] were implementing automated delivery devices with a bar code and placing all medication administration information online.”

— David Bates, MD

Most studies evaluating CPOE systems analyze the economic impacts of computerized order entry, such as decreased length of patient stay and reduced charges.^{9,10} One notable exception is the research that has been conducted by Bates and colleagues at Brigham and Women’s Hospital. In 1998 Bates et al. reported that their CPOE system reduced the overall medication error rate by 55 percent.

In his work, Bates noted that some serious medication errors were not prevented by the CPOE system. He suggested implementing bar-code technology and initiating an online medication administration record.¹¹

Evidence of BPOC Error Reduction

BPOC technology is the advised first step for hospitals in addressing medication errors at the point of care, as it captures the greatest number of otherwise unintercepted errors. Without automation, standard manual nursing practice and pharmacy review are able to eliminate many of the errors that would otherwise reach the patient. With automated bar-code technology at the bedside, error reduction significantly exceeds manual interception and addresses the errors more likely to reach the patient—administration errors. As a result, early adopters of BPOC systems are reporting reductions in medication errors of 67 to 86 percent.

Below is a sampling of publicly stated results of various BPOC systems. Although the study methodologies of these organizations vary, their enthusiastic endorsements of BPOC as a result of the error reduction they have experienced do not waiver.

Decrease in Hospital Medication Errors

St. Mary’s Hospital Medical Center, ^a Madison, WI	67%
North Colorado Medical Center, ^b Greeley, CO	71%
Capitol Region Healthcare, ^c Concord, NH	80%
Comerly-O’Neil VAMC, ^d Topeka, KS	86%
University of Wisconsin Medical Center, ^e Madison, WI	87%

^a American Society of Health-System Pharmacists, “Patient Concern: National Survey Research Report,” 1999.

^b “Attract and Retain RNs.” *Modern Healthcare*, Legislation and Regulation, January 31, 2000.

^c “Information Technology: Medication Errors Reduced by 87% with New Tool, *Drug Week*, December 20, 2002.

^d Joint Commission for the Accreditation of Healthcare Organizations, 2003 National Patient Safety Goals.

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^e B. Stevens, “Using Technology to Keep Patients Safe,” *Pharmacy Practice News*, March 2003.

BPOC SYSTEM BENEFITS BEYOND ERROR REDUCTION

A sound justification analysis is not wholly dependent on error avoidance. Other benefits impact the return on investment.

Market Value of Patient Safety Leadership

The value of perceived safety cannot be overstated. In 1999, Americans cited suffering a medication error while in the hospital as their greatest health-care concern.¹² Hospitals that address this fear are rewarded with patient loyalty and increased market share. However, not all solutions contribute equally to patient satisfaction. Unlike CPOE, patients interact with BPOC technology. As retail consumers, they understand that bar codes are more accurate than humans, and will demand that the same accuracy apply to their medical care.

Nurse Recruiting and Retention

Hospitals hoping to survive the current staffing crisis must establish themselves as premier employers concerned with improving bedside working conditions.¹³ Nurses appreciate a system that safeguards them and their patients from the devastating effects of an adverse drug event. A survey of BPOC users demonstrated a 42 percent improvement in nurse satisfaction with the medication administration and documentation process, and a 64 percent improvement in nurse perception of system safety.¹⁴

Improved Charge Capture

BPOC systems are uniquely able to document medication administration and trigger an immediate charge transaction. Real-time charging improves accuracy and eliminates tedious reconciliation procedures. In addition, the same BPOC

Coding, documenting, and clearing up rejected claims account for one-third of the money Americans spend on healthcare.

infrastructure used to automate medication charge capture provides instant inventory updating for improved supply chain management.

Best Practices Compliance

BPOC systems are uniquely able to collect accurate medication administration data at the bedside, automating documentation. When tied to data from other hospital information systems, clinical reviews can be performed automatically. This allows management to ensure that clinicians are following best practices that improve the quality of care and eliminate waste from ineffective treatment.

JCAHO Regulatory Compliance

The Joint Commission for Accreditation of Healthcare Organizations (JCAHO) has established six patient safety goals including improving accuracy in positively identifying patients prior to drawing blood samples or administering blood products and medications¹⁵—a core functionality of BPOC technology. Experts agree that BPOC systems effectively reduce “wrong patient” errors by up to 93.5 percent.^{16,17,18,19,20,21} In addition, use of a BPOC system aids in meeting JCAHO standards and satisfies requirements for error reporting.

IMPLEMENTATION CHALLENGES

The challenges associated with a successful IT system installation are contingent on the complexity of the selected system, the necessary workflow changes, and the extent of required training and support efforts.

“Clinical applications, especially those used by physicians, are the most difficult to implement, and many view inpatient CPOE as the most difficult of all.”

— California Healthcare Foundation

CPOE

According to a report published by the California HealthCare Foundation, “Clinical applications, especially those used by physicians, are the most difficult to implement, and many view inpatient CPOE as the most difficult of all.”²² Hence, physician resistance to CPOE systems is common.^{23,24}

Seventy percent of surveyed hospitals with CPOE software available were not requiring or encouraging its use.²⁵ More than half of these hospitals reported that 10 percent or less of their physicians were using the system.

The greatest complexity of CPOE is that of human resource management. Resistance to changes in the physician practice undermines CPOE benefits.

CPOE systems require physicians to use computers to enter orders that previously have been entered by hand. Notoriously adverse to clerical tasks, doctors offload order entry to nursing staff or medical residents. With the use of the CPOE system being delegated to others, sophisticated decision support features meant to assist the physician in evidence-based ordering are wasted. Unless physicians real-

ize the immediate benefits of a CPOE system, workflow changes are perceived negatively and threaten continued use.^{26,27,28}

Those physicians who do not oppose these systems on principle approach CPOE with a “what’s in it for me?” attitude. As a result, significant time must be invested in extensive customization of physician order sets tailored to each doctor’s “favorite” orders.^{29,30} Implementing a CPOE system requires hard-to-achieve physician consensus on order sets, protocols, and system alerts and warnings.

CPOE’s impact is not restricted to physicians.

CPOE requires hospitals to devise new policies for verbal orders and for integrating patient records among CPOE and non-CPOE environments. The nursing, pharmacy, and ancillary staff workflows also change with CPOE system implementation.

Due to the many user groups, highly specialized training and support are needed for CPOE system implementation, including numerous training methods, resources, and personnel for around-the-clock technical support for physicians.^{31,32} Often this responsibility falls to nurses, who are provided “super-user training” despite already problematic workloads.

Hospital-wide CPOE system implementation is a 3- to 5-year process that requires 13 dedicated FTEs³³ and has a known risk of failure.

BPOC

BPOC systems are not inherently complex. The technical and time commitments are minor when compared to CPOE system requirements. For many hospitals, the most significant consideration with BPOC implementation is determining how to achieve bar-code labeling of medication containers sent to the patient bedside. This obstacle can be overcome with modest efforts including changing purchasing patterns, exercising

Bar-Coding for Patient Safety

Begin with a review of high-usage medications so that a BPOC system can immediately address the most prevalent threats to patient safety.

The percentage of bar-coded immediate containers can reach 60 to 70+% without significant effort.

- 55 to 60% of oral solid doses and injectable medications administered come unit dose, bar-coded from the manufacturer.
- IVs represent 10 to 15% of all medication orders administered—these can be easily bar-coded using existing labeling functionality of the pharmacy system.

You may increase the percentage of bar-coded medications further by using outsourcing alternatives and employing in-pharmacy repackaging methods—beginning with a focus on high-risk medications.

- 85 to 95% bar-coding is possible through incremental packaging services from drug distributors.
- 90 to 95% bar-coding is achieved by further adding desktop labeling and packaging equipment and other processes in the pharmacy.

outsourcing alternatives, and employing in-pharmacy repackaging methods. Ultimately, the bar-code labeling burden will be lifted when the Food and Drug Administration finalizes a rule to mandate bar-code labeling by pharmaceutical manufacturers on all immediate containers of medications.³⁴

A well-designed BPOC system poses few workflow impediments. By using an electronic source to select, administer, and document medications instead of previous paper-based processes, the medication administration process may be slowed slightly as nurses respond to warnings and alerts issued by the system, but this time loss is balanced by automated documentation of the medications. While the Veteran's Health Administration has reported user frustrations, these have been the result of the poor workflow design of internally developed bar-code medication administration applications. These side effects are not inherent in BPOC technology and are readily addressed by the more advanced BPOC systems available in the marketplace today.

BPOC education and training focus predominantly on nurses, although minor training is also required in the pharmacy. As a rule, nurse mastery of BPOC systems can be accomplished in as little as three to four hours.³⁵ This is an extremely important consideration with the extensive use of temporary outsourced nursing resources in most hospitals. For system maintenance, pharmacists also receive one-time instruction on updating the hospital formulary and on mapping bar codes to the appropriate medication.

Hospital-wide BPOC system implementation is possible within six months with only 2.4 added FTEs.³⁶

WHAT IS IT GOING TO COST?

First Consulting Group (FCG) evaluated CPOE costs, benefits, and challenges in a report for the American Hospital Association and the Federation of American Hospitals.³⁷ The report estimates that CPOE costs a 500-bed hospital with 25,000 annual admissions \$7.9 million in one-time upfront costs, with ongoing costs in the order of \$1.35 million annually.

BPOC system investment generally includes one-time capital and operating costs as well as ongoing costs. The installation of a more advanced BPOC system is estimated to cost a 500-bed hospital with 25,000 annual admissions a one-time upfront investment of approximately \$1.9 million, with ongoing costs of approximately \$180,000 annually.³⁸

“Bedside scanning costs one-fifth of CPOE and needs no IS personnel involvement except setting up the network connections....”

— Steven Rough, Director of Pharmacy,
University of Wisconsin Hospitals & Clinics

What Does an Adverse Drug Event (ADE) Cost?

Bates and colleagues estimate that lengths of stay and charges associated with an injurious medication error average a total cost of \$4,685.³⁹ Others quantify the cost of both preventable and non-preventable adverse drug events (ADEs) at approximately \$2,300.^{40,41,42,43} Hence, a fair estimate for average ADE cost is around \$3,000.

CPOE System Costs	
Based on a 500-bed hospital with 25,000 annual admissions	
Category	CPOE ^a
One-time capital (software, hardware, and network)	\$3,850,000
One-time implementation costs	\$4,050,000
Total one-time costs	\$7,900,000
Annual ongoing costs (including staffing and maintenance)	\$1,350,000
5-year cost of ownership	\$13,300,000

^a First Consulting Group, “Computerized Physician Order Entry: Costs, Benefits and Challenges,” 2003.

Estimating ADE Rates

Research conducted by Classen,⁴⁴ Jha,⁴⁵ Bates,⁴⁶ and Senst⁴⁷ gives us an average ADE incidence rate of approximately 3 percent of hospital admissions. A more detailed model, based on an error rate per medication doses administered, provides greater accuracy but is not applicable to the study of order entry errors. Barker et al. observed that 19 percent of all medications administered are potentially ADEs. Of these, research suggests that 3 percent

result in actual harm.^{48,49} As illustrated below, these two models produce similar estimates for total ADEs at 750 and 798, respectively, or an average of 774 annual ADEs.

Estimating System Cost Avoidance and Payback Period

The aggregate annual cost of these errors can then be determined by applying the average cost of an ADE (\$3,000)^{50,51} to the number of ADEs averaged

Step 1: Estimating ADEs			
Based on 500-bed hospital, 25,000 admissions/year, 2 million doses administered			
ADEs per annual admissions		Errors per annual doses administered	
Annual hospital admissions	25,000	Medication doses	2,000,000
Preventable ADEs (3%)	750	Errors per total doses (195)	380,000
		Potential ADEs (7%)	26,600
		Preventable ADEs (3%)	798
Preventable ADE Average = 774			
Step 2: Estimating Cost Avoidance			
	CPOE	BPOC	
Average preventable ADEs	774	774	
System error avoidance rate	55%	75%	
Preventable ADEs using system	426	581	
Potential cost avoidance (\$3,000)	\$1,277,100	\$1,741,500	
Step 3: Estimating Payback Period			
	CPOE	BPOC	
One-time costs	\$7,900,000	\$1,900,000	
Ongoing annual costs	\$1,350,000	\$180,000	
Cost over 5 years	\$13,300,000	\$2,620,000	
Payback period (in years)	10.4	1.5	

from both models. Research shows that 55 percent of ADEs could be prevented with CPOE,⁵² while BPOC demonstrates an average error reduction of 75 percent.^{53,54} The payback period for CPOE is more than 10 years, while a BPOC system providing \$1.7 million in annual cost avoidance has a payback period of less than two years.

Michigan hospitals can earn up to 4 percent on inpatient reimbursements by implementing medication safety systems.

Conclusion

Although these models are valid for comparison of BPOC and CPOE system returns, the actual payback to the hospital will depend on the organization's reimbursement structure. In the short term, a hospital that is capitated is able to retain more benefit from cost avoidance than is a hospital under a fee for service contract. In the long term, the use of patient safety systems will produce a more efficient hospital that equates to cost-effective care, and patterns of reimbursement will follow suit.

State legislators are calling for Medicare reimbursement for hospitals that implement medication error reducing technology.⁵⁵ It is anticipated that similar carrots will be offered by private payer organizations that see value in reducing the cost of care for their employer customers. For example, Michigan hospitals can earn up to 4 percent on inpatient hospital payments from Blue Cross Blue Shield of Michigan for implementing medication safety improvement initiatives including BPOC technology. Similar legislation has been proposed in Wisconsin, Massachusetts, and California.

The prudent use of capital assets is a matter of life or death for healthcare in more ways than one. Certainly, the success of a strategic capital investment is measured by its contribution to the sustained financial strength of the organization. When that capital investment also protects the lives of patients, the return is invaluable.

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