

Treatment Plan: High Tech Transfusion

Case Statement for Implementation of
CPOE in all Massachusetts Hospitals



MASSACHUSETTS
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*Working in
partnership with
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Case Statement for Implementation of CPOE in all Massachusetts Hospitals

"There are advanced technologies which can dramatically lower health care costs **and** improve quality. The technologies are proven. The associated benefits are known. But there are barriers in the system which impede their implementation.
We can change that."

From: "Advanced Technologies to Lower Health Care Costs and Improve Quality"
Massachusetts Technology Collaborative and the New England Healthcare Institute
October 2003

Computerized Physician Order Entry (CPOE)

is a computer application used by physicians to order clinical services for patients. CPOE improves the accuracy of orders and provides clinical decision support so that the most common medical errors are avoided.

Implementation of these systems has demonstrated substantial cost savings and significant improvement in patient safety and overall quality of care.

The Massachusetts Technology Collaborative(MTC)

MTC's mission is to support the state's innovation economy by acting as a catalyst between the private sector, government and academia. Its major programs include renewable energy, nanotechnology, support for university-based R&D with close industry involvement, and advanced technologies in health care which improve quality and lower costs. Its "2002 Index of the Massachusetts Innovation Economy" identified the Massachusetts life sciences "Super Cluster" as an integrated system of biomedical research, medical education, biotechnology, information technology, medical devices, and related industries.

The New England Healthcare Institute (NEHI)

NEHI specializes in identifying innovative strategies for improving health care quality and reducing health care costs. NEHI conducts independent, high quality research that supports evidence-based health policy recommendations at the regional and national levels. Member representatives from the academic health center, biotechnology, employer, medical device, payer, pharmaceutical, hospital, provider, and research communities bring an unusual diversity of talent to NEHI's work. We collectively address critical health issues through action-oriented research, education, and policy initiatives.

This report was prepared by

First Consulting Group



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What if we could both improve the quality of medical care and decrease its costs by bringing 21st century technology to health care?

If CPOE systems were operating in all acute care hospitals in Massachusetts, patient safety and the quality of patient care could be greatly improved, and costs could be substantially reduced. Yet now, in 2004, **70 percent of all Massachusetts hospitals — 46 institutions — do not have this essential technology.**

The Massachusetts Technology Collaborative (MTC) and the New England Healthcare Institute (NEHI), in conjunction with First Consulting Group (FCG) and a Working Group broadly representing the state's health care system (see inside cover), concluded that **fully implementing CPOE programs in all of the state's acute care hospitals has the potential to reap \$275 million in net cost savings annually to the state's health care system.** Full installation of CPOE systems could be completed for a capital expenditure of \$210 million.

So if a \$210 million investment can generate on-going savings of \$275 million, not to mention significantly improve patient safety and care, what's keeping that investment from happening? This Case Statement first explains the barriers that currently impede the implementation of CPOE systems, and then proposes a solution to these problems. We identify a framework and pathway for universal adoption of CPOE systems in all Massachusetts hospitals.

THE STATE OF THE ART

CPOE Adoption Rates in Massachusetts' Acute Care Hospitals are Very Low

Today, just 10 percent of Massachusetts' acute care hospitals have CPOE systems installed and operational. Another 20 percent are currently in the process of implementing systems. Most often these are the large tertiary care hospitals. The remaining 70 percent of the state's acute care hospitals, typically those with fewer than 500 beds, do not have CPOE systems.

But Why? Barriers to Adoption of CPOE

This is no easy task. There are three significant barriers that hinder the adoption and implementation of CPOE:

- A CPOE system is a major IT installation. Costs can be substantial and may present a significant, and in many cases, overwhelming challenge. Up to this point, it has been difficult to quantify the anticipated savings from implementing such systems, and equally hard to determine to whom the savings accrue (payers vs. providers).
- Resistance to CPOE systems among clinical and administrative staff remains a significant barrier to adoption. Implementation of a CPOE system results in major changes in the work processes of a hospital. Not only is it disruptive, it also requires a reconfiguration of hospital operations and a willingness on the part of the staff to accept change.
- Up to this point, there have been no clear specifications and standards regarding the capabilities and performance of CPOE systems, or guidelines regarding best practices for installation and implementation.

Executive Summary

Costs and Savings for Statewide Implementation

If standardized CPOE systems were installed in each of the 46 Massachusetts hospitals currently not using this technology, total one-time installation costs would be approximately \$210 million. Conservative estimates and accepted studies show total net savings to the health care system in Massachusetts to be at least \$275 million annually. Of this amount, \$175 million would accrue to the hospitals, and the balance of \$100 million to payers and patients.

CLEARING THE PATH AHEAD: Removing the Barriers

- **Standards:** The Case Statement presents a full set of minimum application and performance standards for Massachusetts hospital CPOE systems. Best practices to insure successful implementation are also outlined.
- **Funding and Incentive Model – A “Straw Man”:** Meeting the substantial and in many cases overwhelming capital requirement is critical. And a program of incentives could greatly speed implementation of standard, interoperable systems. As a “straw man” the Case Statement proposes that all payers (health plans, employers, Medicare, and Medicaid) agree to a collaborative approach in which **half of all project costs** would be provided by payers. This support would be made available in two parts: half as a grant paid over project implementation, and half contingent, to be paid depending on the achievement of performance metrics.

Governance, Organization and Resources

In addition to the hospital CPOE project, there are a number of parallel and closely related projects underway. Blue Cross Blue Shield of Massachusetts (BCBSMA) is leading an effort to implement a comprehensive system of standardized Electronic Medical Records (EMRs) across all provider settings in the state, and the American College of Physicians (Massachusetts Chapter) has developed a roadmap and collaborative initiative for the universal installation of EMRs in all of the state's ambulatory settings.

Substantial resources have been committed in support of these efforts. In addition to its planning and organizational resources, Blue Cross has pledged \$50 million toward these combined initiatives. In addition, approximately \$1 million has been committed to the hospital CPOE project by the Massachusetts Legislature and MTC.

A centralized, statewide governing entity, representative of all stakeholders, has been formed and will manage these combined initiatives in a project called the *Massachusetts e-Health Collaborative*. Planning for the “pilot” phase of this effort is already underway.

Next Steps

This Case Statement presents a compelling case for a broad-based collaborative effort to install CPOE in all the Massachusetts hospitals that do not now have these systems. But it is only an initial framework and pathway. As part of the Massachusetts e-Health Collaborative, the CPOE initiative should undertake detailed planning and analysis to include refinement of specifications and standards, negotiation with key vendors, agreement among stakeholders on specifics of a funding and incentive program, and a project timetable. Planning and implementation should be integrated with the “pilot” phase of the e-Health Collaborative as appropriate, and thereafter carefully sequenced with other elements of the comprehensive effort to maximize the effectiveness of a state-of-the-art, interoperable, state-wide system.

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I. CPOE Adoption Rates in Massachusetts' Acute Care Hospitals are Very Low

Today, just 10 percent of Massachusetts' acute care hospitals have CPOE systems installed and operational. Another 20 percent are currently in the process of implementing CPOE systems. Most often these are the large tertiary care hospitals. The remaining 70 percent of the state's acute care hospitals (46 institutions typically those with fewer than 500 beds) do not have CPOE systems.

JUST A FEW EARLY ADOPTERS

While estimates of the number of U.S. hospitals that have effectively implemented CPOE systems are varied, it is clear that adoption rates of CPOE in hospitals nationwide are low. Results from a recent survey by The Leapfrog Group ¹ demonstrate that progress toward fully-implemented CPOE is very slow. According to the Leapfrog survey, approximately 300 of the nation's 4,900 non-government hospitals have implemented CPOE systems (representing six percent of all non-government hospitals). However, less than one percent of all hospitals have actually met Leapfrog's standards for CPOE

implementation, a standard that requires that prescribing clinicians enter at least 75 percent of all medication orders via a CPOE system with specific capabilities. ²

In Massachusetts, CPOE installation appears to be no better. A recent survey conducted for this report shows that CPOE has been fully deployed in fewer than 10 percent of all acute care hospitals in Massachusetts, and that another 20 percent are in the process of implementing CPOE. Results from the most recent Leapfrog Survey of acute care hospitals validate this level of CPOE implementation in Massachusetts. ³

Table 1: CPOE Implementation in Massachusetts

Respondents <i>with</i> CPOE systems installed	Number	% of all Respondents
CPOE has been installed across a majority of hospital's clinical services	3	7.3%
CPOE is being installed across a majority of hospital's clinical services	10*	19.5%
Total	13	31.7%
Respondents <i>without</i> CPOE systems installed	Number	% of all Respondents
Total	28	68.3%

*Includes two hospitals that reported having CPOE - one of which installed CPOE in its oncology clinic but reported no further plans, and another which piloted CPOE but has no current plans for further implementation.

Source: First Consulting Group survey

TEACHING HOSPITALS LEAD THE WAY

When viewed by hospital size, it becomes clear that the largest of the Commonwealth's hospitals are much more likely to have installed CPOE systems than their smaller counterparts. These larger hospitals also tend to be located in Boston's more urban areas. According to the FCG survey data, while 75 percent of Massachusetts' largest hospitals (>500 beds) have purchased and installed CPOE systems, less than one-third of the Commonwealth's medium (150-499 beds) and small (<150 beds) hospitals have either purchased or begun to install a CPOE system. The remaining hospitals in all size categories have not yet purchased a CPOE system.

We assumed that the level of CPOE implementation among hospitals that did not respond to the survey is approximately the same as that of hospitals that did respond. We then estimated the current implementation status of CPOE systems across all Massachusetts' acute care hospitals (see Appendix A) and calculated the total CPOE implementation costs in Chapter IV and the benefits of CPOE in Chapters V and VI. More detailed investigation of CPOE implementation status for Massachusetts hospitals is expected to occur as this initiative gets underway.

II. Barriers to Adoption of CPOE

Multiple factors have contributed to the low rates of adoption of CPOE systems nationwide and in Massachusetts hospitals.

MONEY, MONEY, MONEY

First, installation of CPOE systems requires a major commitment of capital and operating funds. Many Massachusetts hospitals, and in particular the smaller institutions that have not yet made the commitment to implement CPOE systems, have limited financial resources and access to capital. For these institutions, operating margins over the past decade have generally been well below the national averages, with the result that they have poor access to capital and are among the most debt-ridden in the country. In addition, the capital demand for other pressing needs such as advanced clinical equipment and facilities is unrelenting.

To date, there has been uncertainty with respect to the extent of cost savings which can be expected as a result of CPOE implementation. In particular, it has been unclear up until now as to how much of the savings generated would accrue to which of the key stakeholders (providers vs. payers).

CHANGE IS DIFFICULT

Second, implementation of CPOE will require major modification to the hospital's work processes and work flows. Substantial organizational inertia must be overcome. It will change, in some instances radically, the way hospital staff do their jobs. Resistance to CPOE systems among clinical and administrative staff remains a significant barrier to adoption. Not only is CPOE technology disruptive, but it also requires a reconfiguration of hospital operations and a willingness, on the part of the staff, to accept change.

NO STANDARDS

There have been no clear specifications and standards regarding the capabilities and performance of the CPOE systems, or guidelines regarding best practices for installation and implementation.

III. Standards and Requirements for Achieving Success

Notwithstanding the small percentage of hospitals in the country that have implemented CPOE, there is substantial experience with successful implementations that sheds light on what appropriate application standards should be, and what "best practices" might be. This section presents a model for standards and best practices.

Success with CPOE requires implementing systems throughout the hospital and using the decision support tools that can screen for unintended errors and consistently guide care decisions toward recommended clinical practices. The work of implementing CPOE requires commitment and leadership, careful attention to the details of order writing and subsequent work flows, and a partnership with physicians to support them through the transition.⁴

One critical contributor to an efficient and successful implementation is the CPOE application itself — the way it is designed to be used. Many Massachusetts hospitals have not yet determined which software vendor's program to implement. Proposed standards in four areas are reviewed below, along with technical and functional requirements that make the work of implementing CPOE easier and increase its likelihood of success.

How to Choose? CPOE Software Purchasing Strategies

Many hospitals in Massachusetts have not yet selected or purchased the software application that will support CPOE

deployment. This decision involves a number of different considerations and, in the end, tradeoffs.

There are three vendor strategies to consider in today's clinical system software marketplace:

1. Using CPOE software from the organization's current Hospital Information System (HIS) vendor
2. Replacing some or all of the organization's HIS vendor applications with a new suite of clinical applications that includes CPOE
3. Installing a different vendor's CPOE program that "wraps around" the organization's legacy HIS applications

The advantages and disadvantages of these approaches are described further on the table that follows:

Table 2: Selecting a CPOE Program

	1. Using CPOE Capabilities from Current HIS Vendor	2. Replacing Some or All of the HIS Vendor Applications with a New Vendor Suite	3. Installing a Different Vendor's CPOE Program that Wraps Around Legacy HIS Applications
Description	Hospitals today have an information system with applications that support admissions/discharge and basic order management; many HIS vendors also offer advanced clinical applications such as CPOE and an electronic medication administration record (e-MAR).	A number of vendors offer a suite of clinical applications including CPOE. Because a minimum set of applications is needed for CPOE, this approach often requires replacing and/or duplicating software applications already in use.	Several vendors now offer CPOE and other advanced clinical applications designed to integrate with a hospital's legacy HIS. This does not necessarily require duplicating HIS applications and databases.
Advantages	<ul style="list-style-type: none"> ■ Adding CPOE involves less disruption of current systems and processes ■ Likely to implement more quickly than a replacement solution – and costs less 	<ul style="list-style-type: none"> ■ Provides an opportunity to select a solution that meets full CPOE requirements ■ In some cases also provides an opportunity to upgrade a hospital's technical architecture 	<ul style="list-style-type: none"> ■ Provides an opportunity to select a solution that meets full CPOE requirements ■ In some cases it also provides an opportunity to upgrade a hospital's technical architecture ■ Cost and time to operational CPOE likely to be less than Option 2
Disadvantages	<ul style="list-style-type: none"> ■ Not an option if CPOE product does not meet requirements in Appendix B 	<ul style="list-style-type: none"> ■ Costs and time to operational CPOE are typically greater than Options 1 or 3 ■ The IS department may need to manage two application architectures and their integration, requiring higher level skill sets than needed for the HIS (for a period of time) 	<ul style="list-style-type: none"> ■ Cost and time to operational CPOE likely to be greater than Option 1 ■ Vendors and/or CPOE solutions are new to the marketplace ■ The IS Department needs to manage two application architectures and their integration, requiring higher level skill sets than needed for the HIS

The Basics: A Minimum Application Suite

The software application for CPOE is not sold, and cannot be implemented, as a stand-alone product. As a result, decisions about CPOE have much broader implications for the entire suite of software applications supporting clinicians and pharmacists in the hospital setting.

Most vendors describe the minimum suite of applications required to make CPOE functional as:

- Order Management and Results Reporting

- Clinical Data Repository (or patient database, which may also include a rules engine)

- Rules Engine, if not integrated into other applications

- Physician Portal integrating CPOE and Results Management

In addition, most hospitals plan to implement additional clinical applications to support nursing processes and to capture clinical documentation notes. In order to provide necessary patient information for the decision support tools in CPOE (e.g. allergies, weight), some online nursing documentation is also required to make CPOE functional.

Because of the complexity of medication management, patient medication orders must be passed across the hospital's pharmacy, medication administration, and nursing applications to support each step needed to respond to the physician's order and to deliver the medication to the patient. This need to support the roles and work of the physician, the pharmacist, and nurse leads many hospitals to make decisions about CPOE concurrent with decisions about the hospital's entire clinical application suite.

The Rubber Hits the Road: Standards and Requirements for CPOE

The design of the CPOE application is an important prerequisite for an efficient and successful implementation. Because order writing – the core process that CPOE supports – is very complicated, the full set of technical and functional requirements for accomplishing CPOE numbers in the thousands. However, measures of overall success can be streamlined to evaluate a program's performance.

We propose four standards for determining the "success" of a hospital CPOE implementation:

- A. The percent of physician orders entered electronically for hospital patients

- B. The extent to which the CPOE program is managing inpatient orders in the hospital

- C. The performance of the clinical decision support tool

- D. The interoperability of the electronic medical record (EMR) system in which CPOE functions

Each of these standards is described in more detail below and further detail about the first three requirements is provided in Appendix B.

A. Standards and Requirements for Physician Acceptance

Standard: Physicians are using CPOE to directly enter at least 75 percent of the inpatient orders at the hospital.

Requirements: The time required to learn CPOE and to write orders is the biggest concern raised by physicians. Judging the success of the design requires examining how the CPOE system presents information and expects physicians to respond in a typical patient care situation. In the absence of an industry third-party rating, the "right" solution is the one that a representative group of physicians in the hospital believes they could (and would be willing to) use. The following list highlights aspects of CPOE design that are major acceptability factors for physicians:

- ✓ Design of order screens and data entry that reflects how physicians think about and write orders and that minimizes the time required to do so
- ✓ Ease of locating the orders of interest for each patient
- ✓ Design of messages and tasks so that a physician can easily identify and attend to outstanding items by type, by patient, by urgency
- ✓ Delivery of relevant and useful prompts and alerts to guide and critique order entry when the physician is contemplating what to order
- ✓ Ease of responding to prompts and alerts for orders

B. Standards and Requirements for Implementation

Standard: The CPOE application is processing orders of all types (medications, tests and procedures, consults, etc.) throughout all inpatient units of the hospital.

Requirements: The following list defines several characteristics of the application architecture that determine how easily the CPOE application can be implemented and maintained:

- ✓ Physician portal technology or remote connectivity that facilitates universal physician access to CPOE and Results Management whenever and wherever physicians make care decisions
- ✓ Interoperability with the pharmacy application that enables the necessary two-way flow of medication orders
- ✓ Availability of a mobile device for CPOE that mimics how physicians interact with CPOE at the fixed workstation
- ✓ Comprehensive order sign-off capabilities as required in pending Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requirements
- ✓ System utilization reporting that details physician participation for monitoring, targeting follow-up, and documenting successful adoption

For hospitals using or planning to install a software application that maintains the medication administration record, interoperability between that software and CPOE is desirable. Recent JCAHO proposals to require bar coding at the point of care, if adopted, will accelerate plans for this application in many hospitals.

C. Standards and Requirements for the Performance of CPOE

Standard: The CPOE system as implemented is able to intercept at least 50 percent of the common medication errors that harm patients.

Requirements: The major value of CPOE comes from its ability to guide and critique physician orders to avoid adverse events and improve the overall quality of care. Success in realizing this value requires both an appropriate set of clinical decision support tools and the ability to apply those tools in an effective way. The following elements of a CPOE system are necessary to achieve expected clinical and financial benefits:

- ✓ Basic medication checking (e.g. drug-drug and drug-allergy interactions; drug-drug duplicate and therapeutic overlap checking; drug-laboratory checking)
- ✓ Single, cumulative, and patient-specific medication dosage checking that incorporates patient-specific age, weight, diagnosis, and other information
- ✓ Design of medication checking rules that gives hospitals

control of basic medication checking and screening levels for drug interactions (and does not require writing unique rules for every situation)

- ✓ Tools to suggest clinically appropriate interventions (e.g. automatic display of linked secondary orders, order sets, laboratory duplicate checking, automatic display of relevant test results)
- ✓ Tools to suggest more cost-effective interventions (e.g. advisories about cost and formulary adherence)

D. Standards for Interoperability

The Institute of Medicine (IOM) and many other organizations point to the importance of achieving interoperability of electronic medical records so that patient medical record information can be made available **across sites and settings of care**.^{5 6 7} Although many cross-industry initiatives currently underway may yield EMR standards in the future, these standards are still evolving and cannot be specified at this time.

Other Considerations in Reaching a Final Decision

The requirements discussed above are useful for differentiating vendor solutions in any hospital. Some HIS vendors that currently offer CPOE solutions will be unable to meet all of these requirements. As a result, there are often trade-offs between the extent to which a vendor can provide all of the capabilities described and the importance to the hospital of having those capabilities. Selecting a vendor that offers all of these capabilities provides greater assurance that the hospital's CPOE implementation will succeed, but it may not always be feasible for a hospital to abandon its current HIS solution in favor of one that can provide stronger CPOE capabilities.

Beyond the requirements for physician acceptance, implementation, performance, and interoperability, the following perspectives are also essential for hospitals to consider when assessing vendor applications:

- ✓ Vendor track record in achieving successful implementation, including system reliability and response time, in hospitals of comparable size and complexity
- ✓ Fit of the vendor technology architecture with the hospital's technology strategy
- ✓ Vendor adherence to standards that promote interoperability among information systems (including LOINC, SNOMED, DICOM, HL-7 3.0, and ICD-10CM, all of which are rapidly gaining support for industry adoption)
- ✓ Technical requirements of implementation and ongoing maintenance and their match with local skills and resources
- ✓ Cost and purchase options offered by the vendor

IV. Implementation and Ongoing Costs

Total project costs for CPOE installation in Massachusetts hospitals without these systems would amount to approximately \$210 million. The ongoing operating costs would be approximately \$25 million annually.

The costs of successfully implementing hospital-based CPOE systems can vary widely depending on a number of factors: the state of the current information systems and network environment at the hospital, the size of the organization, the CPOE capabilities of the hospital's current information system vendor, and the readiness of the organization to install CPOE.

Key Assumptions

We made several key assumptions when we analyzed the costs associated with installing and operating CPOE systems:

- Costs will vary as a direct correlation to the size of the hospital
- The state of the hospital's information technology infrastructure is up to date and stable. However, the addition of a wireless network (a component deemed essential by hospitals successfully installing CPOE ⁸) is included in the cost figures
- Resource time is necessary for process and workflow changes that are critical for CPOE, although in practice there is widespread variation depending on the organization's readiness to move from paper-based processes to clinical decision-supported CPOE

Projected CPOE Implementation Costs for Massachusetts Hospitals

For hospitals in the process of selecting and implementing a CPOE application, there are three potential options to consider (as discussed in Section III):

1. Retain the hospital's incumbent core HIS vendor and install that vendor's CPOE module
2. Retain the hospital's incumbent core HIS vendor and install a wraparound CPOE/portal solution from another vendor
3. Replace the entire HIS suite with a new vendor's applications

To build a robust model, cost profiles for each of these options were developed and further refined by hospital size. Costs have been categorized as follows:

- One-time capital costs, including hardware; software; computer networking equipment (including wireless network capabilities); workstations, printers, and handheld wireless devices; and implementation services, including assistance in change management from the vendor or outside consultants
- One-time operating costs, including leadership resources to direct the project and ensure physician participation; and information systems analysts, physicians, and other clinical resources to design, configure, and install the system, including all of the essential rules and alerts that make the CPOE system effective (one-time operating costs may include incentive payments to physicians to facilitate adoption of the new systems)
- Annual operating costs, including the costs associated with maintaining the hardware, software, network equipment, computer interfaces, and user devices (including reviewing and updating all of the clinical rules and alerts on a regular basis)

The following series of tables summarize the estimated costs for implementing CPOE based on hospital size and the three system options previously discussed.

Option 1: Retain Incumbent Hospital Information System and Add CPOE

The baseline projection reflects 500-bed hospitals that are implementing CPOE as an add-on module to the hospital's core clinical information system with the following assumptions:

- CPOE implementation includes interfaces to laboratory, radiology, and pharmacy systems, or the system is already integrated with these modules

- The organization's current computer network does not require any upgrades in order to support CPOE
- A wireless network of devices is required to support mobile entry of electronic orders
- No other clinical and business applications are required

Scaled-down costs are also projected for a medium-sized hospital of approximately 250 beds and for a hospital of fewer than 150 beds.

Table 3: Estimated Costs of Inpatient CPOE – Retaining Current HIS Vendor

Component	Projected Cost: 500-Bed Hospital	Projected Cost: 250-Bed Hospital	Projected Cost: <150-Bed Hospital
Total One-Time Capital	\$4,850,000	\$3,000,000	\$1,800,000
Total One-Time Operating	\$3,050,000	\$2,000,000	\$1,300,000
Total One-Time Installation Costs (Capital plus Operating)	\$7,900,000	\$5,000,000	\$3,100,000
Total Annual Ongoing Costs	\$1,350,000	\$700,000	\$300,000

Sources: Costs for a 500-bed hospital based on actual figures from five hospital case studies cited in the report, "Computerized Physician Order Entry: Cost, Benefits and Challenges," written for the American Hospital Association (AHA) and the Federation of American Hospitals (FAH) by First Consulting Group, January 2003. Costs for a 250-bed hospital calculated for "Advanced Technologies to Lower Health Care Costs and Improve Quality," Massachusetts Technology Collaborative, 2003. CPOE costs for <150 beds were further scaled down from both sources.

Option 2: Retain Incumbent HIS Vendor and Install a Wraparound CPOE/Portal Solution

This baseline projection applies to hospitals that are implementing a wraparound CPOE application on top of the hospital's core clinical information system using the following assumptions:

- The costs for new CPOE application software and hardware are included in the one-time capital costs
- Time and resources for selecting a vendor product are included in the one-time operating costs
- CPOE implementation includes interfaces to laboratory, radiology, pharmacy systems, and the hospital's core HIS application
- The organization's current computer network does not require any upgrades in order to support CPOE
- One-time operating costs are the same as those for Option 1 (using the hospital's current HIS vendor)
- A wireless network is required to support mobile entry of electronic orders
- No other clinical and business applications are required

Table 4: Estimated Costs of Inpatient CPOE – Installing Wraparound CPOE

Component	Projected Cost: 500-Bed Hospital	Projected Cost: 250-Bed Hospital	Projected Cost: <150-Bed Hospital
Total One-Time Capital	\$6,500,000	\$3,900,000	\$2,300,000
Total One-Time Operating	\$3,050,000	\$2,000,000	\$1,300,000
Total One-Time Installation Costs (Capital plus Operating)	\$9,550,000	\$5,900,000	\$3,600,000
Total Annual Ongoing Costs	\$1,500,000	\$770,000	\$350,000

Sources: Derived from CPOE cost estimates in the AHA/FAH report, "Computerized Physician Order Entry: Cost, Benefits and Challenges," with one-time capital and operating costs adjusted based on FCG market intelligence for purchasing and installing wraparound CPOE vendor solutions.

Option 3: Replace Entire Hospital Information System Suite

This baseline projection applies to hospitals that are replacing their current core HIS applications with another vendor's clinical suite, using the following assumptions: (See Table 5)

- Time and resources for selecting the HIS application suite are included in the one-time operating costs
- The cost for new clinical system software and hardware is included in the one-time capital costs
- The implementation includes interfaces to laboratory, radiology, and pharmacy systems, or these systems are already integrated with the hospital information system
- The organization's current computer network does not require any upgrades in order to support CPOE
- A wireless network is required to support mobile entry of electronic orders
- The costs for converting data from the hospital's current HIS application are not included in this model

Projected CPOE Implementation Costs for Massachusetts Hospitals That Have Not Yet Implemented CPOE

Based on our survey and estimates of the extent of CPOE deployment across the Commonwealth (see Appendix A), there are 46 hospitals in Massachusetts that have not begun to implement CPOE systems. In using the numbers outlined above to estimate the costs of implementing CPOE across these 46 hospitals, a number of assumptions have been made:

- One-time costs would be spread out evenly over the three-year implementation period
- CPOE would be fully installed at each hospital after Year 3
- On-going operating costs would begin in Year 1
- All costs for the four federal government's Veteran's Affairs hospitals in Massachusetts would be excluded
- Eighty percent of hospitals are likely to install the CPOE solution offered by their current HIS vendor (Option 1), with ten percent opting to install a wraparound solution (Option 2) and ten percent opting to replace their HIS vendor application altogether (Option 3)

Table 5: Estimated Costs of Inpatient CPOE – Replacing Current HIS Application Suite

Component	Projected Cost: 500-Bed Hospital	Projected Cost: 250-Bed Hospital	Projected Cost: <150-Bed Hospital
Total One-Time Capital	\$11,000,000	\$6,000,000	\$3,500,000
Total One-Time Operating	\$6,000,000	\$3,000,000	\$2,000,000
Total One-Time Installation Costs (Capital plus Operating)	\$17,000,000	\$9,000,000	\$5,500,000
Total Annual Ongoing Costs	\$2,000,000	\$1,000,000	\$400,000

Sources: Derived from CPOE cost estimates in the AHA/FAH report, "Computerized Physician Order Entry: Cost, Benefits and Challenges," with one-time capital and operating costs adjusted based on FCG market intelligence for purchasing and installing complete HIS vendor solutions.

Based on these estimated costs, the Massachusetts survey findings, and our assumptions, the total costs for implementing and supporting CPOE in Massachusetts hospitals that have not yet done so are detailed in the table below:

We have detailed the costs of installing and operating inpatient CPOE systems as a prelude to determining the net financial benefits that might accrue to each stakeholder in the health care system. Section V defines the financial benefits associated with installing and effectively using CPOE in all Massachusetts hospitals, and Section VI provides an analysis to allocate those financial benefits to the stakeholders (providers vs. payers).

Table 6: Total Projected Costs for Installing CPOE Across Massachusetts Hospitals that Have not yet Begun Implementation

Component	Hospitals Retaining Current HIS Vendor and Adding CPOE	Hospitals Installing Wraparound CPOE Solution	Hospitals Replacing HIS Vendor Application	Total Costs
Initial Installation Costs (Capital and One-Time Operating)	\$153.7 million	\$22.6 million	\$35.0 million	\$211.3 million
Annual Operating Costs	\$19.5 million	\$2.7 million	\$3.4 million	\$25.6 million

Source: First Consulting Group calculations

V. Financial Benefit

The financial benefit associated with implementation of CPOE in all Massachusetts hospitals is substantial. On a gross basis it is estimated to approximate \$1.48 billion annually.

The significant benefits from CPOE include improvements in the clinical quality of care and reductions in cost. The benefits are typically achieved through reducing medication errors and standardizing care. Cost reductions most often come from providing more cost-effective treatment alternatives, reducing duplicate orders, and lowering resource utilization.

Improved Quality

Medication safety is by far the most widely-cited benefit of CPOE. Numerous studies have quantified the rates of medical errors, adverse drug events (ADEs), and potential ADEs.

According to the Institute of Medicine Report, *To Err is Human*, between 44,000 and 98,000 deaths each year are attributable to medical errors.⁹ Studies in New York, Utah, and Colorado demonstrated that drug complications constitute 19 percent of all adverse events in hospitals, and that overall 2.9 percent to 3.7 percent of admissions are complicated by adverse events—over half of which were the result of medical errors that could have been prevented.⁸

CPOE can play a significant role in decreasing the number of ADEs. A study performed at Brigham and Women's Hospital (Boston, Massachusetts) demonstrated a 55 percent reduction in serious medication errors and a 17 percent decrease in ADEs.¹⁰ A study at Latter-Day Saints Hospital (Salt Lake City, Utah) showed a 70 percent reduction in ADEs related to antibiotics.¹¹

CPOE can also offer multiple tools to assist in standardizing care delivery, including the use of order sets that execute multiple, associated tests; recommendations for corollary or secondary orders; and display of current practice guidelines for care and treatment. Representative findings from studies conducted over the past several years include:

- Increased compliance with recommended orders from 21.9 percent to 46.3 percent
- Reduction in inappropriate antibiotic use of 75 percent
- Increased use of preferred H2 blocker from 15.6 percent to 81.3 percent⁸

Finally, the speed of electronic delivery of orders provides opportunities to decrease turnaround times for medication delivery, lab specimen collection, and completion of other diagnostic tests. For example, Montefiore Medical Center in New York City demonstrated a 58 percent reduction in medication turnaround time after the implementation of CPOE, and estimated savings of two hours per day for each ward clerk, 20 minutes per day per nurse, and 200 minutes per day per pharmacist.⁸

. . . and Reduced Costs

Reduced costs from CPOE are achieved through the reduction of medication errors and ADEs, as well as through the use of decision support capabilities that improve resource utilization and lower hospital length of stay. Examples of cost reductions associated with CPOE include:

- Reduction in pharmacy charges of \$500,000 through a recommended dosage change for a single drug (representing a 92 percent switch rate to a new dose)⁸
- Reduction in drug costs (\$340 to \$102 per patient), hospital length of stay (from 12.9 to 10.0 days) and overall hospital costs (from \$35,283 to \$26,315) from a CPOE program used for antibiotic ordering¹¹
- Reduction in total inpatient charges of 12.7 percent with CPOE use¹²
- Reduction in emergency department expenditures by \$26 per visit¹³
- Reduction of preventable inpatient ADEs with a cost of \$6,000 per admission¹⁰

Benefit to Massachusetts

For the purposes of this model, only benefits that could be generalized and quantified across all Massachusetts hospitals and the entire patient population were included. These benefits — seen as universally accepted and conservative — include the following:

1. **Reduction of inpatient ADEs and improved utilization of inpatient resources** — Two studies formed the basis for the inpatient benefits calculation. A study at Brigham and Women's Hospital (Boston, Massachusetts)¹⁰ calculated a cost of \$6,856 (in 2004 dollars) for each preventable inpatient ADE, with an occurrence rate for those ADEs of 1.46 percent. A study at the Regenstrief Institute (Indianapolis, Indiana) demonstrated a 12.7 percent reduction in charges per admission with the use of CPOE, taking into consideration better resource utilization and prevention of medication errors.¹² Understanding that some of these study findings overlap, total annual savings in the Massachusetts health care system would reach **\$1.48 billion**, assuming a CPOE adoption rate of 100 percent, an 80 percent benefits accrual rate, 809,857 discharges a year, and an average case cost of \$17,610 (in 2004 dollars).¹⁴

Reflecting only those hospitals that have not yet begun CPOE implementation, the projected inpatient savings would be **\$787 million** per year.

2. **Improved utilization of Emergency Department (ED) resources** — Based on a Regenstrief Institute study of emergency departments (ED),¹³ savings of \$26 per encounter (in 2004 dollars) were achieved in 50 percent of the ED cases when prior patient clinical data was available at the point of care. The potential savings when applied to Massachusetts' ED visits is over **\$30 million** annually if all Massachusetts hospitals install CPOE and achieve 80 percent of the estimated benefit after three years.

Reflecting only those hospitals that have not yet begun CPOE implementation, the projected ED savings would be **\$16.7 million** per year.

The total estimated annual benefit for inpatient CPOE in the entire Massachusetts health care system, assuming 100 percent adoption across all hospitals and accrual of 80 percent of the benefits after three years, is **\$1.48 billion**. Reflecting only those hospitals that have not yet begun CPOE implementation, the total projected savings would be **\$803.4 million** (before adjustments for fixed versus variable costs, see Section VI). These estimates may be low as they do not include specific niche benefits (e.g., antibiotic medications, brand-to-generic medication switching, and intensive care unit length-of-stay decreases) and other intangible benefits cited in the literature.

VI. Allocation of Net Financial Benefit

The financial benefit of CPOE installation in the hospitals which *do not now have the systems* would amount to net adjusted savings of almost \$275 million annually. Of this amount, \$175 million would accrue to the hospitals and \$100 million to payers.

While hospitals bear the costs of purchasing, implementing and maintaining CPOE systems, they accrue only a portion of the financial benefits associated with these systems. A sizable portion of the financial benefits also accrue to purchasers and payers, and in some cases to patients. The stakeholder that actually receives the CPOE benefits is determined by two factors: the type of CPOE benefit, and the type of reimbursement involved.

Three Types of CPOE Benefits

The CPOE benefits detailed in Chapter V of this report and used to calculate the overall CPOE benefit for Massachusetts reflect the following types of potential savings:

1. A decrease in hospital lengths-of-stay when inpatient ADEs are reduced or eliminated through the use of CPOE, as well as a decrease in the utilization of other inpatient services
2. A decrease in the utilization of inpatient resources when CPOE systems identify tests that have already been performed and/or provide the ordering physician with better treatment options
3. A decrease in utilization of ED resources when CPOE systems are installed

Each of these benefits accrues to a different stakeholder depending on who's paying for the patient's care in any given situation.

Table 7: Predominant Payment Mechanisms and the Associated Accrual of Benefits

Reimbursement Mechanism and Description	To Whom Benefits Accrue
1. DRG (diagnostic-related groupings) – Flat-rate payment by procedure and diagnosis for all inpatient services regardless of length-of-stay APC (ambulatory payment classifications) – Flat-rate payment by procedure and diagnosis for all ambulatory services provided (<i>In this report, these reflect ED charges</i>)	■ Savings from reduced lengths-of-stay and from decreased utilization of services accrue to the hospital
2. Per-diem – Per-day payment based on type of hospital service to which patient is admitted (i.e., ICU, medical, surgical) Per-visit – Covers ED services provided as well as – not all – ancillary charges	■ Savings from decreased lengths-of-stay accrue to the payer, whereas savings from decreased utilization of most ancillary services accrue to the hospital
3. At-risk capitation – Per-member-per-month payment negotiated between the payer and hospital or health system to cover <i>most</i> of the hospital and ancillary services provided to a defined patient population	■ Savings from decreased lengths-of-stay and decreased utilization of services accrue to the contracting entity (hospital or health system)
4. Fee-for-service and discount fee-for-service – Payment based on agreed-upon fees, sometimes calculated with a discount	■ Savings from decreased lengths-of-stay and decreased utilization accrue to the payer
5. Free care – Hospitals and payers contribute funding to a state-wide pool of money that is paid back to hospitals that provide certain levels of uncompensated care to patients	■ Annual contributions are made to the Massachusetts free care pool by both hospitals and payers
6. Self-pay – Uninsured patients not eligible to receive free care pay directly for services provided based on a fee scale	■ Savings from decreased lengths-of-stay and decreased utilization accrue to the patient

Source: FCG discussions with managed care and financial reimbursement experts

Types of Reimbursement

Different reimbursement mechanisms place the cost burden on different stakeholders. Under some common reimbursement mechanisms, payers negotiate contracts with hospitals that effectively delegate the responsibility for managing some or all of the patients' inpatient costs to the hospital. Under other mechanisms, payers themselves gain or lose when hospital lengths-of-stay increase or when more inpatient and ED services are ordered. Finally, in a few cases, the cost burden falls squarely on the patient.

Under those reimbursement mechanisms that effectively shift the burden for managing costs to hospitals, hospitals that can reduce costs through their use of CPOE systems benefit from the associated savings. On the other hand, under reimbursement mechanisms that pay hospitals more money for greater volumes of services, it is the payers and patients that benefit when fewer services are ordered and provided.

Payment for hospital services involves a multitude of arrangements and payer types. In addition to Medicare, Medicaid, and private insurers, there are life insurers, automobile insurers, and workers compensation programs that reimburse providers under certain circumstances for patient care. These latter non-health care insurers typically reimburse providers

on a fee-for-service basis. In addition, large employers often enter into arrangements whereby their employee health insurance programs are "self-insured." Under these arrangements, the employer is acting in the role of a payer and assumes all of the risks (and/or benefits) associated with increased (or decreased) utilization of health care services by its employees.

With the help of experts in the field of managed care and financial reimbursement, the six predominant payment mechanisms in Massachusetts were identified and defined. They are listed in Table 7, along with which stakeholder can expect to benefit from decreased utilization of services that result from the use of CPOE. Specific examples can be helpful in illustrating how savings from CPOE would accrue to different stakeholders depending on the reimbursement mechanism in place. Under DRG and APC reimbursement arrangements, the burden of managing patient costs falls on hospitals, since the total amount paid by the insurer for a given diagnosis and procedure doesn't vary whether the patient stays in the hospital longer or utilizes more services. When CPOE systems help reduce the length of time that the patient remains in the hospital, or eliminate redundant or unnecessary services during that hospital stay, the hospital will gain financially. Conversely, the hospital will lose ground when patients stay

Table 8: Stakeholders That Benefit Under Each Reimbursement Mechanism

Reimbursement Mechanism	To Whom Benefits Accrue	
	Improved Utilization of Inpatient Resources and Reduction of Inpatient ADEs	Improved Utilization of ED Resources
1. DRG and APC	Hospital	Hospital
2. Per-diem and per-visit	Payer (length-of-stay): 70% Hospital (utilization): 30%*	Hospital
3. At-risk capitation**	Hospital	Hospital
4. Fee-for-service and discount fee-for-service	Payer	Payer
5. Free care	Hospital Payer	Hospital Payer
6. Self-pay	Patient	Patient

*The proportion between the two benefits was estimated by the CPOE expert who authored the study on the reduction of inpatient ADEs as follows: 70percent from decreased length of stay and 30percent from decreased ancillary utilization.
 **In some cases hospitals share benefits with physicians' groups.
 Source: FCG discussions with managed care and financial reimbursement experts

longer or require more services.

When the six reimbursement types (described in Table 8) are aligned with the three categories of CPOE benefits, it becomes clear which stakeholder benefits under each payment mechanism.

Determining the Current Proportions of Reimbursement

In order to determine which stakeholders receive the actual financial benefits calculated in Chapter V of this report, we needed to understand the proportion of inpatient and ED services that these stakeholders currently pay in Massachusetts. The following data-gathering and analytical steps were undertaken to make those determinations:

1. A list of the inpatient charges by payer for care provided during 2002 in Massachusetts was obtained from the HealthShare database. This list provided the total inpatient charges for each of the insurance plans and payers in the Commonwealth.
2. Each of the payers on this list was categorized according to the six types of reimbursement mechanisms described above. For example, because inpatient charges for HMO Blue are paid by contract on a DRG basis, those charges were categorized as DRG. This exercise was completed for all 121 insurance plans and payment types across Massachusetts. In a few limited cases, inpatient charges are paid using a blended formula of both DRG and per diem mechanisms. In those cases, the corresponding charges were split and apportioned equally to each of the two categories.

3. The list was then sorted according to the six reimbursement types and all of the inpatient charges associated with each payment mechanism were totaled.
4. The percentage that each reimbursement mechanism represents relative to all of the inpatient charges for Massachusetts was then determined.
5. A similar exercise was undertaken to determine the percentages of charges for outpatient ED care – with one key exception. Because the same HealthShare data for Massachusetts' ED charges was not available, the list of insurance plans for Massachusetts was re-categorized – this time according to how ED charges are paid under each plan. For example, because ED charges for HMO Blue are paid by contract on a fee-for-service basis, HMO Blue was categorized as fee-for-service for the purposes of ED charges. Once all of the insurance plans were re-categorized and sorted according to the ED payment mechanisms, the percentage of each reimbursement type could be applied to the total ED charges for Massachusetts. The key assumption underlying this approach is that the proportion of each plan's ED charges (as a percentage of the total ED charges for Massachusetts) is the same as that plan's proportion of the inpatient charges.

The results of this categorization and analysis are listed in the following table.

Table 9: Proportion of Inpatient and ED Charges in Massachusetts Associated with Each Reimbursement Mechanism

Reimbursement Mechanism	Proportion of All Inpatient Charges in MA	Proportion of All ED Charges in MA
1. DRG and APC	64.2 %	38.3 %
2. Per-diem and per-visit	9.0 %	4.6 %
3. At-risk capitation	10.1 %	10.1 %
4. Fee-for-service and discount fee-for-service	13.7 %	43.7 %
5. Free care	1.7 %	1.7 %
6. Self-pay	1.3 %	1.3 %

Source: First Consulting Group calculations

It is important to note that the mix of reimbursement mechanisms prevalent in Massachusetts has changed slightly since 2002 – with hospital risk decreasing and consumer responsibility and payments increasing – and that this trend is likely to continue to change as this CPOE initiative moves forward.

Allocating the CPOE Benefits

With the proportion of charges for each payer now determined, those proportions can be applied to each of the three CPOE benefit categories outlined earlier in this chapter, and to the corresponding dollars that are projected to be saved through the use of CPOE (as calculated in Chapter V of this report).

It should be noted that the reduction in inpatient and ED services resulting from CPOE will translate differently for hospitals than it will for payers or patients. Since there is a fixed cost component for all hospital services, a reduction in the number of tests or inpatient days will result in some savings to the hospital but not the total charges for that service. Payers and patients, on the other hand, can expect to experience the full extent of the savings.

Table 10: Allocation of CPOE Benefits

Reimbursement Mechanism	Allocation by Type of CPOE Benefit		Total	Allocation by Stakeholder		
	Improved Utilization of Inpatient Resources and Reduction of Inpatient ADEs	Improved Utilization of ED Resources		Hospitals	Payers/Employers	Patients
1. DRG and APC	\$930.2 million	\$11.8 million	\$942.1 million			
2. Per-diem and per-visit	\$130.4 million	\$1.4 million	\$131.8 million			
3. At-risk capitation	\$146.4 million	\$3.1 million	\$149.5 million			
4. Fee-for-service	\$198.5 million	\$13.5 million	\$212.0 million			
5. Free care	\$24.5 million	\$0.5 million	\$25.0 million			
6. Self-pay	\$18.8 million	\$0.4 million	\$19.2 million			
Total CPOE Benefit – All Massachusetts Hospitals			\$1.48 billion	\$1.2 billion (84%)	\$219.9 million (15%)	\$19.2 million (1%)
A. Expected CPOE Benefit for Massachusetts Hospitals Currently Lacking CPOE			\$803.4 million	\$673.6 million (84%)	\$119.4 million (15%)	\$10.4 million (1%)

As a result, the following assumptions have been included in the final benefit allocation calculations:

- For benefits that accrue to payers and patients, 100 percent of the calculated benefit is assigned
- For benefits that accrue to hospitals, **only 40 percent** of the calculated value is assigned, since it is assumed that 60 percent of the costs are fixed.

Table 10 summarizes the total benefits that would accrue to each stakeholder when the adjustments noted above are factored in to the data in Tables 8 and 9. It is important to note that these benefits include expected savings across all payers in Massachusetts – including Medicare and Medicaid programs.

Row A identifies CPOE benefits for those hospitals currently lacking the systems. The lower section of the table shows those benefits adjusted for hospitals' fixed and variable costs. In Row B, only 40 percent of the benefit (the variable component) is projected to accrue to the hospitals, because it is assumed that 60 percent of hospitals' costs are fixed. And finally Row C presents a conservative estimate of the adjusted CPOE benefit and assumes that only 75 percent of the benefit will be realized. On this basis, a total of \$300 million would be saved in the Massachusetts health care system. (**Net benefit** is calculated on the following page.)

CPOE Benefits — Adjusted for Hospitals' Fixed Costs

B. Expected CPOE Benefit	\$399.3 million	\$269.4 million (67%)	\$119.4 million (30%)	\$10.4 million (3%)
C. Conservative CPOE Benefit (75% of B)	\$299.4 million	\$202.1 million (67%)	\$89.6 million (30%)	\$7.8 million (3%)

Net Benefits

Table 11 approximates the system-wide cash flow that would result in a comprehensive implementation of CPOE systems in the hospitals that have not yet installed them given the costs and conservative estimate of benefits. It shows that positive cash flow could be achieved in a short period of time and that the net annual financial benefit would be significant. **Annual net savings** would approximate \$275 million.

The following calculations and assumptions were included:

- One-time costs are evenly distributed over three years
- Ongoing support costs are allocated each year beginning in Year 1
- No benefits accrue in Year 1; twenty-five percent of the adjusted benefits are accrued in Year 2 and 100 percent in Year 3 and every year thereafter

**Table 11:
Conservative Net Incremental Benefit to Massachusetts of Inpatient CPOE
(Reflecting Hospitals That Have Not Yet Implemented CPOE)**

	Year 1	Year 2	Year 3	Years 4 and Beyond
Projected Costs	\$96.0 million	\$96.0 million	\$96.0 million	\$25.6 million
Expected Savings	—	\$74.9 million	\$299.4 million	\$299.4 million
Conservative Net Benefit	(\$96.0 million)	(\$21.1 million)	\$203.4 million	\$273.8 million

VII. Proposed Funding and Reimbursement Model

The goal of the proposed funding and reimbursement model is to speed adoption of standard, interoperable CPOE systems by addressing some of the key financial barriers that impede implementation. Understanding that monetary benefits accrue to both payers and providers, the model proposes a matching program in which payers would support half of the implementation costs. Of this amount half would be paid as a grant over the course of installation with the balance held on a contingent basis to assure that performance standards are achieved.

Principles

The following principles have been formulated for the development of a program to address the financial needs of Massachusetts hospitals that want to implement CPOE:

1. Funding and reimbursement mechanisms will fairly reflect the allocation of the cost-saving benefits (as outlined in Chapter VI).
2. The funding model will include a "material" contribution to the capital cost made by all payers, and thus address hospitals' capital financing needs.
3. The model will provide incentives, including payments to physicians, to assure that implementation milestones and performance standards are met (see Appendix E).
4. Financial support by payers and the incentives they provide hospitals and physicians for adopting CPOE should be **disengaged from reimbursement and related negotiations**.
5. All payers, public and private, should participate in the funding and reimbursement program in order to "level the playing field" and fairly reflect the expected allocation of financial benefits.
6. Both hospitals and physicians should be eligible for financial incentives under the proposed reimbursement program – but only if they meet certain criteria for participation (see Appendix E).
7. Hospitals that have already purchased CPOE systems will not be penalized for their early implementations but will be granted parity through an appropriate mechanism.

THE PROPOSED FUNDING AND REIMBURSEMENT MODEL — A "Straw Man"

■ Matching Program:

The implementation of CPOE systems would be a collaborative undertaking of providers and payers. Participating hospitals would install CPOE systems that meet agreed-upon standards, and payers would agree to support half of all project implementation costs. The payers' support would be divided into two equal portions:

- o Half would be in the form of a grant, paid to the provider as required by the schedule of project implementation

- o The other half would be paid over time, contingent on the achievement of milestones and performance metrics (See Appendix E)

■ Physician Incentives:

The ongoing burden to install and use CPOE systems falls on physicians as well as hospitals. Many physicians practice independently in community settings, are not hospital employees, and admit patients to several hospitals. The challenges of getting community physicians to learn and use CPOE systems are well documented.⁴ Since physicians are critical to the success of CPOE, they will also need to participate in a financial incentives program, the specifics of which are yet to be finalized.

No comparable state program involving CPOE bonuses for community physicians has been identified, although the pay-for-performance program in California rewards physicians for using an EMR as part of the payment formula. One vehicle for administering the payments might be a clearinghouse into which payers contribute monies that would be dispersed to qualifying physicians.

■ Special Financing Requirements for Hospitals:

The majority of the hospitals that have not yet implemented CPOE are community hospitals, many of which have had poor financial performance over the past decade. Their operating margins generally have been well below the national averages, with the result that they often have poor access to capital. Having weak balance sheets overall, they are among the most debt-ridden hospitals in the country. For these institutions, access to the capital necessary to meet the hospital share of the matching program could be difficult.

The Massachusetts Health and Educational Facilities Authority has indicated a willingness to create a statewide financing program to meet the needs of these institutions. The program would be dependent on a substantive provider contribution to be used to purchase CPOE systems together with some form of special reserve and third-party credit enhancement, the specifics of which are yet to be finalized. A combination of these elements could provide investors with sufficient security to look beyond the finances of each individual hospital.

VIII. Governance, Organization and Resources

This Massachusetts Hospital CPOE Initiative is one of several exciting and critically important ventures that seek to accelerate the implementation of clinical information technology systems across the state. A cross section of stakeholders, led by Blue Cross Blue Shield of Massachusetts (BCBSMA), has framed a vision for the implementation of standard and interoperable EMR capability across all provider settings in the state. And the American College of Physicians, Massachusetts Chapter, has developed a roadmap and collaborative initiative for the installation of EMRs in all of the Commonwealth's ambulatory care settings.

Substantial resources have been committed in support of these initiatives. In addition to its planning and organizational resources, Blue Cross has pledged \$50 million toward these combined efforts. In addition, approximately \$1 million has been committed to the hospital CPOE project by the Massachusetts Legislature and MTC.

A centralized, statewide governing entity, representative of all stakeholders, has been formed and will manage these combined initiatives in a project called the *Massachusetts e-Health Collaborative*. Planning for the "pilot" phase of this effort is already underway.

Next Steps

The Case Statement here presents a compelling case for a broad-based collaborative effort to install CPOE in all the Massachusetts hospitals that do not now have these systems. But it is only an initial framework and pathway. As part of the Massachusetts e-Health Collaborative, the initiative should now undertake detailed planning and analysis to include refinement of specifications and standards, negotiation with key vendors, agreement among stakeholders on specifics of a funding and incentive program, and a project timetable. Planning and implementation should be integrated with the "pilot" phase of the e-Health Collaborative as appropriate, and thereafter carefully sequenced with other elements of the comprehensive effort to maximize the effectiveness of a state-of-the-art, interoperable, state-wide system.

Appendix A:
Estimated Progress Towards CPOE Implementation Across All Massachusetts Hospitals

Assuming that the level of CPOE implementation among hospitals that did not respond to the survey is approximately the same as that at hospitals which *did* respond, estimates of the current status of CPOE across all of Massachusetts hospitals can be summarized in the following table:

	Small Hospitals (< 150 Beds)	Medium Hospitals (150-499 Beds)	Large Hospitals (>500Beds)	Total
MA Hospitals with CPOE Systems Installed				
Survey Respondents	0	0	3	3
Non-Survey Respondents (projected)	0	2*	1	3
Totals	0	2	4	6
% of All Hospitals	0	2.9%	5.8%	8.7%
MA Hospitals with CPOE System Purchased and Implementation Underway				
Survey Respondents	3	7**	0	10
Non-Survey Respondents (projected)	3	4	0	7
Totals	6	11	0	17
% of All Hospitals	8.7%	15.9%	0	24.6%
MA Hospitals without CPOE				
Survey Respondents	12	15	1	28
Non-Survey Respondents (projected)	11	6	1	18
Totals	23	21	2	46
% of All Hospitals	33.3%	30.4%	2.9%	66.7%
*Based on reported results from a Leapfrog Survey of Massachusetts hospitals' CPOE adoption in 2002				
**Includes two medium hospitals who reported having CPOE but not throughout the entire hospital				

Appendix B: Detailed Description and Implications of CPOE Requirements

The following provides more information about the functional and technical requirements for the CPOE application discussed in Section III of this report.

A. Critical CPOE Requirements for Physician Acceptance		
Requirement	Description	Implication
1. Design of order screens and data entry that align with how physicians think about and write orders. Complex medication orders such as sliding scale and IVs with customized admixtures are types of orders for which the design makes a big difference.	Information displays array order information in the way that physicians are accustomed to thinking about orders, including consideration of the type and amount of information physicians are required to enter.	The design approach influences how much effort is required to learn and use the system to write actionable orders.
2. Ease of locating the orders of interest for each patient.	Options are available for the physician to locate and call up individual and groups of orders for a particular patient, including personal and departmental favorites, diagnosis- or situation-specific care sets, and order sets incorporating options and instructions relating to options.	The effort physicians must expend locating orders in the system contributes to the time required for writing orders.
3. Ability to accommodate all order types.	All types of orders – including laboratory, radiology, and pharmacy can be generated using the same orders module and screens.	Using different modules and screens to complete all orders for a specific patient is time consuming.
4. Design of messages and tasks so that a physician can easily identify and attend to outstanding items by type, by patient, by urgency. Good designs include an "inbox" and annotated patient lists.	New information (new lab results and alerts requiring attention) and outstanding tasks (orders expiring, orders to sign) are clearly identified; flagged as new, abnormal and/or STAT; and easily viewed.	For physicians, an important part of the value proposition for doing electronic ordering is assistance with handling patient management and communication tasks.
5. Delivery of prompts and alerts to guide and critique ordering at the most useful time for the physician.	Clinical decision support information is delivered when the physician is considering what to order, aiding in the selection of appropriate orders or recommending appropriate dosing or other parameters.	The sooner decision support feedback is integrated into ordering tasks the better. The worst case is an array of alert messages delivered at the time the physician is attempting to sign orders.
6. Ease of responding to prompts and alerts for orders.	Physician can display in one view and accept with one click all advice about order interventions, recommended doses, and other order elements.	This feature has a big effect on time to accomplish ordering, as well as acceptance of clinical decision support that CPOE can deliver. The worst case is requiring the physician to start over writing the order rather than quickly accepting a recommended change.

B. Critical CPOE Requirements for Implementation

Requirement	Description	Implication
1. Physician portal technology that facilitates universal physician access to CPOE.	System offers a physician portal and connectivity for remote access that is reliable and easily implemented and maintained (many CIOs look to browser-based technology for these characteristics).	Physicians must be able to access CPOE whenever they are making decisions about their patients – in the hospital, at their office or from home.
2. Integration with the pharmacy application, enabling the necessary two-way flow of data between the CPOE and pharmacy applications and ensuring that patient care and pharmacy processes are based on the same information.	Medication orders are seamlessly transmitted from the CPOE system to the pharmacy application, and an electronic acknowledgement of medications dispensed is automatically sent from the pharmacy application back to the CPOE system. The best way to validate this requirement is by contacting current implementation sites for the vendor.	Physicians order medications a certain way, whereas pharmacists often need to process orders and prepare medications for distribution employing different units of measure. Making the necessary translations can be difficult.
3. For hospitals with a current or planned electronic medication administration record (MAR), interoperability enabling the necessary two-way flow of data between the CPOE and MAR applications and ensuring that ordering and medication processes are based on the same information.	Medication orders are seamlessly transmitted from the CPOE system to the MAR application, and an electronic acknowledgement of medications administered is sent from the MAR application back to the CPOE system. The best way to validate this requirement is by contacting current implementation sites for the vendor.	Without this interoperability, physicians can't be provided with a real-time view of administration status for their orders with pertinent nursing comments (patient response, vital signs taken at administration, etc.) and nurses must enter STAT (first-dose) orders for physician orders not yet verified by pharmacy.
4. Design for a mobile device that physicians can use for CPOE and that mimics as much as possible the screen layout they see on the fixed workstation.	Mobile devices offer a fully-functional range of electronic tasks that physicians perform.	Mobile computing is a requirement for physician acceptance. The ability to write orders, as well as look at results, on the mobile device becomes essential once physicians are engaged in CPOE.
5. Comprehensive display of current orders for physician sign-off.	Order displays allow physicians to view all current patient orders, along with new orders, when the physician is electronically signing orders.	This is a pending requirement of the JCAHO.
6. Reports detailing for each physician the volume of inpatient orders entered directly into CPOE versus written or communicated verbally.	Physician leaders and project staff need to monitor physician utilization to assess progress and target individual physicians for additional training and follow-up. For this purpose, the CPOE application needs to make reports available on a scheduled and ad hoc basis.	Both for managing roll-out and for substantiating utilization statistics requested by external parties, project leaders need access to system reports.

C. Critical CPOE Requirements for Performance

Requirement	Description	Implication
1. Drug-drug and drug-allergy interaction checking; drug-drug duplicate and therapeutic overlap checking.	CPOE system links to the patient's current medication profile and automatically screens new orders for preventable drug interactions and duplications.	These tools are necessary to perform basic checking of medication orders for appropriateness.
2. Hospital control of the level of checking for standard medication screening.	System can set different levels of severity alerting for individual medications.	This feature is important for sufficiently fine-tuning medication-related advisories and alerts so as to achieve an acceptably low level of "nuisance" alerts.
3. Single and cumulative medication dosage checking.	System automatically factors into dosage checking the accumulated doses for a medication during a patient's stay.	This feature is necessary to extend dosage checking to some high-risk medications.
4. Medication-laboratory checking.	System automatically screens patient history for relevant laboratory results to detect possible contraindications with certain medications.	This feature is necessary for screening certain high-risk medications.
5. Medication dosage checking incorporating patient-specific age, weight, diagnosis, and other information.	System automatically factors relevant patient information into dosage checking, as relevant to particular medications requiring this level of detail.	This feature is necessary for screening many high-risk medications.
6. Patient-specific medication dosage checking set-up that does not require writing a unique rule for each unique set of conditions to be flagged.	Table-driven design, which simplifies establishing and maintaining the rules for drug checking. A good way to evaluate this feature is to ask for a demonstration of the process for setting up patient-specific dosing.	Writing individual rules (using a rules engine) is not practicable for the large number of situations involved.
7. Automatic display of linked secondary orders.	System displays additional recommended orders to accompany an order (e.g., laboratory test to titrate dosing based on medication blood level achieved).	This is a proven tool for addressing omissions in care management.
8. Laboratory duplicate checking.	System flags laboratory tests as potentially unnecessary duplicates based on hospital-established time limits for prior tests.	This is a proven tool for reducing unnecessary testing.
9. Automatic display of laboratory test results and vital signs relevant to medication order.	System can associate medications and relevant lab tests for automatic display with a medication order.	This both reminds a physician to consider the relevant information and makes it easy to do so.
10. Pre-defined sets of orders for a particular diagnosis and/or situation (e.g., post-op).	Physician can select and edit sets of orders as necessary before signing. Ideally physicians have several options such as order sets, diagnosis finder, order sets including likely options, intelligent care sets –customizable at the individual physician level.	Pre-defined orders are developed to incorporate recommended clinical practices.
11. Cost advisories.	System displays orderable item costs as part of an order template and/or recommendations concerning lower-cost interventions for patient.	These are proven tools for encouraging cost-effective care management and reminding physicians of applicable recommendations of hospital committees.
12. Medication orders default to formulary options or list those first.	Making the selection of formulary medications easy increases compliance with formulary management.	Formulary management can improve the cost-effectiveness of medications ordered. Incorporating formulary advisories in CPOE increases compliance with hospital formulary.

Appendix C: Massachusetts' Acute Care Hospitals

The following lists the Massachusetts hospitals that are considered "acute care hospitals" for the purposes of this report. Massachusetts' Veterans Hospitals (which are funded by the Department of Veterans Affairs and which already use their own homegrown CPOE system), and hospitals that are

primarily hospice, long-term care, or mental health facilities are excluded from this list and from all calculations in this report. Bed size information was taken from the American Hospital Association's 2002 AHA Guide.

Hospital Name	Location	Number of Beds
Massachusetts General Hospital	Boston	868
Southcoast Health System	Fall River/New Bedford/Wareham	806
Brigham and Women's Hospital	Boston	709
UMass Memorial Hospital	Worcester	707
Baystate Health System	Springfield	583
Beth Israel Deaconess Medical Center	Boston	506
Boston Medical Center	Boston	464
Berkshire Health Systems	Pittsfield	398
Tufts-New England Medical Center	Boston	374
Metrowest Medical Center	Framingham/Natick	372
St. Vincent Hospital at Worcester Medical	Worcester	369
Mercy Hospital	Springfield	357
Beverly Hospital	Beverly	339
Children's Hospital	Boston	324
Cape Cod Hospital, Falmouth Hospital	Hyannis/Falmouth	311
Cambridge Health Alliance	Cambridge/Somerville/ Everett	297
Brockton Hospital	Brockton	265
Salem Hospital	Salem	260
South Shore Hospital	South Weymouth	252
Caritas St. Elizabeth's Medical Center	Brighton	250
Lahey Clinic	Burlington	248
Newton-Wellesley Hospital	Newton	242
Melrose-Wakefield Hospital	Melrose	234
Lowell General Hospital	Lowell	231
CaritasHoly Family Hospital and Medical Center	Methuen	230
Caritas Norwood Hospital	Norwood	225
Caritas Carney Hospital	Dorchester	205
Holyoke Hospital	Holyoke	202
Lawrence General Hospital	Lawrence	199
Caritas Good Samaritan Medical Center	Brockton	182
Mount Auburn Hospital	Cambridge	182
Winchester Hospital	Winchester	176
Quincy Medical Center	Quincy	174

Hospital Name	Location	Number of Beds
Emerson Hospital	Concord	165
Anna Jacques Hospital	Newburyport	164
HealthAlliance Hospitals	Leominster/ Fitchburg	156
Morton Hospital and Medical Center	Taunton	152
Saints Memorial Medical Center	Lowell	150
Jordan Hospital	Plymouth	138
Lawrence Memorial Hospital	Medford	134
Faulkner Hospital	Boston	130
Heywood Hospital	Gardner	129
Merrimack Valley Hospital	Haverhill	129
Union Hospital	Lynn	129
Franklin Medical Center	Greenfield	126
Cooley Dickinson Hospital	Northampton	125
Sturdy Memorial Hospital	Attleboro	124
Milford Whitinsville Regional Hospital	Milford	116
Harrington Memorial Hospital	Southbridge	113
Saint Anne's Hospital	Fall River	107
New England Baptist Hospital	Boston	105
Milton Hospital	Milton	97
Noble Hospital	Westfield	97
North Adams Regional Hospital	North Adams	86
Marlborough Hospital	Marlborough	79
Fairview Hospital	Great Barrington	46
Hubbard Health Systems	Webster	45
Massachusetts Eye and Ear Infirmary	Boston	45
Clinton Hospital	Clinton	45
Wing Memorial Hospital	Palmer	41
Beth Israel-Deaconess Needham Campus	Needham	41
Nashoba Valley Medical Center	Ayer	41
Athol Memorial Hospital	Athol	33
Mary Lane Hospital	Ware	31
Dana Farber Cancer Institute	Boston	27
Martha's Vineyard Hospital	Oak Bluffs	25
Nantucket Cottage Hospital	Nantucket	19

Appendix D: CPOE Resources

The following resources are helpful in understanding the costs, challenges and best practices for inpatient CPOE:

- *AHA Guide to Computerized Physician Order Entry Systems*. American Hospital Association, November 2000.
www.aha.org
- Metzger J. and Fortin J. *Computerized Physician Order Entry in Community Hospitals: Lessons from the Field*. The California HealthCare Foundation and First Consulting Group, June 2003.
www.chcf.org
- Metzger J. and Turisco F. *Computerized Physician Order Entry: A Look at the Vendor Marketplace and Getting Started*. The Leapfrog Group, December 2001.
http://www.leapfroggroup.org/CPOE_Reports.htm
- *Computerized Physician Order Entry: Costs, Benefits and Challenges*. The American Hospital Association, the Federation of American Hospitals, and First Consulting Group, January 2003.
http://www.hospitalconnect.com/aha/key_issues/patient_safety/resources/index.html
- Kilbridge P., Welebob E. and Classen D. Overview of the Leapfrog Group Evaluation Tool for Computerized Physician Order Entry. The Leapfrog Group, December 2001.
http://www.leapfroggroup.org/CPOE_Reports.htm
- Drazen E., Kilbridge P., Metzger J., and Turisco F. *A Primer on Physician Order Entry*. The California HealthCare Foundation and First Consulting Group, September 2000.
www.chcf.org
- *Understanding Hospital Readiness for Computerized Physician Order Entry*. Joint Commission Journal on Quality and Safety. July 2003, 29: 336-344.
www.jcaho.org
- *The Journal of Healthcare Information Management*, Volume 18, Number 1 (Winter 2004).
www.himss.org

Appendix E: Certification of Standards and Performance

Certification of Hospitals' CPOE Capabilities and Implementation Levels

In order to receive the financial contribution hospitals must demonstrate that they meet two key criteria:

- The hospital's CPOE system must include decision support tools to guide and critique ordering and the system must be configured for use
- Minimum thresholds of the hospital's clinical orders must be entered using the CPOE system

Demonstrating that CPOE is performing in a way that delivers value will require subjecting the organization's CPOE application to a series of pre-determined tests involving sample patients and test orders. The self-assessment procedure already developed by The Leapfrog Group could serve as ready-made performance certification criteria for Massachusetts. If the CPOE application as configured can effectively screen out test orders that would cause patients harm, then the system performance will be deemed compliant with the desired level of effectiveness.

Determining what percentage of the hospital's clinical orders is entered by physicians can be accomplished with standard reporting features of CPOE software applications. The initial threshold for partial financial support might require that 50 percent of the hospital's orders are entered into the CPOE system by physicians, while full financial support might require that 75 or 80 percent of the hospital's orders are entered by physicians. These threshold reimbursement levels could be increased statewide as the project progresses and CPOE implementation becomes more prevalent. The threshold set by The Leapfrog Group is 75 percent of orders for hospitalized patients.

The hospital CEO will certify performance test results, as well as the extent of physician direct entry. Certification will be repeated annually and the financial support adjusted as appropriate.

Certification of Physicians' CPOE Compliance

The process by which CPOE bonus payments are paid to physicians will require a hospital to submit reports to a centralized clearinghouse detailing the number of patients each community physician admitted to that hospital and the percentage of clinical orders each physician entered using the hospital's CPOE system. Bonuses would be paid to individual physicians by the clearinghouse based on whether the physician admitted a minimum number of patients per year to any of the state's hospitals (as a threshold for volume of inpatient

work) and whether he or she used the hospital's CPOE system for at least 75 percent of their hospital-based orders. Certification of physician CPOE participation would be repeated annually and bonus payments adjusted accordingly.

Evaluation of Results

One final recommended component of Massachusetts' CPOE program will be a series of studies designed to confirm the actual savings hospitals achieve through use of these systems. (Participation in these studies might even be incorporated as a requirement that hospitals must meet in order to receive financial support from payers.) Undertaking these studies would be a significant challenge, requiring consensus regarding the expected areas of savings, the metrics to be studied, and the methodology for collecting and reporting data. Such a study would serve as a significant contribution to the field of CPOE since no similar study involving a large number of hospitals has been undertaken to date.

Some examples of the benefit areas that might be studied include the following:

- Change in reported medication error rates - particularly for preventable ADEs
- Compliance with formulary medications
- Cost per DRG or APC for certain diagnoses (or ratios of certain tests ordered per inpatient diagnosis)
- Cost per ED encounter (or ratios of certain tests ordered per ED visit)

Specific challenges in undertaking this evaluation include ensuring that the data are generally available; convincing hospitals to share them; designating the resources to collect pre- and post-implementation data; and aligning study methodologies and data across various hospital organizations so that results can be compared.

These funding and reimbursement components are one piece of a more extensive implementation infrastructure that would need to be put in place as the Massachusetts' CPOE program gets underway.

Endnotes

1. The Leapfrog Group (www.leapfroggroup.org) was founded in 2000 by The Business Roundtable (www.businessroundtable.org) - a national association of Fortune 500 CEO's - to enhance the dialogue among purchasers, providers, and consumers to initiate breakthrough improvements in patient safety and reduce preventable medical mistakes.
2. Freudenheim M. "Many Hospitals Resist Computerized Patient Care," New York Times, April 6, 2004. www.nytimes.com/2004/04/06/technology/06errors.html?ex=1082257494&ei=1&en=f1648b0cc3e5121b
3. From survey results posted on The Leapfrog Group website (http://www.leapfroggroup.org/consumer_intro.htm) accessed April 24, 2004. See also the Massachusetts Healthcare Purchasers Group website (<http://www.mhpg.org/pdfs/nr12-12-2002.pdf>) for earlier results.
4. Metzger J. and Fortin J. "Computerized Physician Order Entry in Community Hospitals: Lessons from the Field." The California HealthCare Foundation and First Consulting Group, June 2003. www.chcf.org.
5. Institute of Medicine, Committee on Data Standards for Patient Safety. Patient Safety: Achieving a New Standard for Care, Washington, D.C., National Academy Press; 2004
6. Thompson, T.G., and Brailer, D.J. The Decade of Health Information Technology: Delivering Consumer-centric and Information-rich Health Care, U.S. Department of Health and Human Services, 2004.
7. See also HIMSS (the Health Information Management and Systems Society) at <http://www.himss.org/asp/issuesbytopic.asp?TopicID=24>.
8. "Computerized Physician Order Entry: Costs, Benefits, and Challenges - A Case Study Approach," First Consulting Group for the American Hospital Association and the Federation of American Hospitals, January 2003.
9. Institute of Medicine, Committee on Quality in Healthcare in America. To Err is Human: Building a Safer Health System, Washington, D.C., National Academy Press; 1999.
10. Bates D.W. et al. "Effect of Computerized Physician Order Entry and a Team Intervention on Prevention of Serious Medication Errors," Journal of the American Medical Association 1998; 280: 1311-16.
11. Evans P.S., Pestotnik S.L., Classen D.C., et al. "A Computer-Assisted Management Program for Antibiotics and Other Anti-Infective Agents." New England Journal of Medicine 1998; 338:232-8.
12. Tierney W.M., Miller M.E., Overhage J.M., et al. "Physician Inpatient Order Writing on Microcomputer Workstations: Effect on Resource Utilization." JAMA 1993;269:379-383.
13. Overhage, J.M., Dexter, P.R., et al. "A Randomized Controlled Trial of Clinical Information Shared from Another Institution." Annals of Emergency Medicine 39:1 January 2002.
14. Massachusetts Health Data Consortium Case Mix Report for 2001.
15. See the Leapfrog Group website at [https://leapfrog.medstat.com/\(tu5yasvgw3i1t355shhp0v55\)/index.aspx](https://leapfrog.medstat.com/(tu5yasvgw3i1t355shhp0v55)/index.aspx).

Notes

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