Efficiency Gains with Computerized Provider Order Entry

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Abstract

Objective: The objective of this project was to measure efficiency gains in turnaround times with the implementation of a computerized provider order entry (CPOE) system. **Methods:** Pre- and post-CPOE turnaround times (TATs) were measured for orders placed for laboratory, radiology, and pharmacy. The pre-CPOE group was nonrandomized and included a convenience sample of 240 patients with a sample of 1,420 total orders (laboratory N = 340; radiology N = 490; and pharmacy N = 590). The post-CPOE group was randomized and included 241 patients with a sample of 2,390 total orders (laboratory N = 750; radiology N = 680; and pharmacy N = 960). **Results:** TATs were statistically significantly lower ($P < 0.0001$) in all three departments: laboratory TATs decreased 54.5 percent, from 142 to 65 minutes; radiology TATs decreased 61.5 percent, from 31.0 to 11.9 hours; pharmacy TATs decreased 83.4 percent, from 44.0 to 7.3 minutes. **Conclusion:** Implementation of CPOE resulted in dramatic improvements in TATs, which, in turn, can lead to more timely treatment of patients and enhanced communication of results to providers. It also supports the effort to improve quality of patient care and patient safety.

Introduction

Computerized provider order entry (CPOE) is an electronic process that allows a health care provider to enter orders electronically and to manage the results of those orders. CPOE has received increased attention, based on the Institute of Medicine (IOM) reports, *To Err Is Human: Building a Safer Health System*[1] and *Crossing the Quality Chasm: A New Health System for the 21st Century*,[2] and the recommendation of the Leapfrog Group (a coalition of public and private organizations providing health care benefits) that hospitals introduce systems for prescribing and that they be rewarded for it.[3] In 1994, Sittig and Stead[4] wrote a groundbreaking article on computerized order entry, and although much has since changed, we find that adoption of CPOE hinges largely on the financial investment and medication safety aspects of the technology. Our intent in this article is to describe further value in clinical efficiency of CPOE.

In order to improve both quality of care and patient safety, health care systems are implementing CPOE in ever increasing numbers. However, CPOE implementation is more than an information technology change; it involves a major change in health care delivery in both clinical and ancillary departments. It is not simply a technology implementation but a redesign of complex clinical processes, integrating technology at key points to enhance and optimize ordering

- Creating a culture of clinicians and managers working together as partners, not as adversaries.

The team addressed many issues, including development of common order lists and disease-based order sets, required data elements, appropriate order limitations, and other facets of system configuration and integration that were based on clinicians understanding information technology (IT) workflow and IT understanding clinical workflow. The goals the team identified included:

- Reducing the potential for human error.
- Reducing time to care delivery.
- Improving order accuracy.
- Decreasing time for order confirmation and turnaround.
- Improving clinical decision support at the point of care.
- Making crucial information more readily available.
- Improving communication among physicians, nurses, pharmacists, other clinicians, and patients.

A primary focus of the team was to integrate the computerized ordering process into the workflow of the providers and ancillary staff. In addition, the team was instrumental in setting direction for the overall rollout of CPOE, developing approaches to effective training and prioritizing requests for system enhancements. The team developed policies and procedures to support new operational workflow changes. These new approaches to implementation involved physicians, nurses, pharmacists, other clinicians, and IT staff.

The initial patient care unit for CPOE was the medical intensive care unit (MICU). Over the ensuing period, CPOE was rolled out progressively to the medical and surgical patient care units as well. As part of the project implementation evaluation, turnaround times for orders in medical-surgical patient care units were evaluated in each of three ancillary departments: radiology, laboratory, and pharmacy, and the pre- and post-CPOE turnaround times were measured for orders placed for these three departments.

Pre-CPOE measurements were conducted on a convenience sample of 240 patient records, which were reviewed by direct observation in real time (laboratory N = 340; radiology N = 490; and pharmacy N = 590). We observed a total sample of 1,420 orders from April through June 2005. In the pre-CPOE measurement, laboratory turnaround times were measured as the interval between the time the order was written and the time preliminary results became available to clinicians. Radiology turnaround times were measured as the interval between the time the order was written and the time the results became available to clinicians. Pharmacy turnaround times were measured as the interval between the time the order was written and the time it was verified by pharmacy/automated dispensing device release.

In the post-CPOE analysis, a randomized group of 241 patient records was reviewed (laboratory N = 750; radiology N = 680; and pharmacy N = 960). We observed a total sample of 2,390 orders between April and June in 2006. In the post-CPOE measurement, laboratory turnaround times were measured as the interval between the time the order was entered into CPOE and the time preliminary results became available to clinicians; radiology turnaround times were measured as the interval between the time the order was entered into CPOE and the time results

became available to clinicians; and pharmacy turnaround times were measured as the interval between the time the order was entered into CPOE and the time the order was verified by pharmacy/automated dispensing device release. All statistical analyses were performed using SPSS® software (Version 14.0). $P < 0.05$ (two-tailed) represented a statistically significant difference.

Results

Turnaround times for orders placed to all three ancillary departments decreased significantly when the pre- to post-CPOE time periods were compared. Absolute reductions in TAT occurred in all three departments, with decreases of 79 minutes for laboratory orders, 1,146 minutes (19.1 hours) for radiology, and 36.7 minutes for pharmacy. As shown in Table 1, TATs decreased by 55.6 percent ($P < 0.0001$) for laboratory, 61.6 percent ($P < 0.0001$) for radiology, and 83.4 percent ($P < 0.0001$) for pharmacy.

Table 1. Turnaround times before and after CPOE implementation

Department	Pre-CPOE		Post-CPOE		Percentage improvement	*P*- value
	N	Min	N	Min		
Laboratory	340	142	750	63	55.6	<0.0001
Radiology	490	1,860	680	714	61.6	<0.0001
Pharmacy	590	44	960	7.3	83.4	<0.0001

Discussion

The single most studied benefit of CPOE has been the reduction in medication errors. However, other benefits include process improvement, cost-conscious decisionmaking, clinical decision support, and efficiency. Time efficiency incorporates nearly all these identified factors and is a high priority in health care today. End-users more often recognize CPOE's efficiency aspects than its technology advances. Specifically, with enhanced time efficiency, clinicians can communicate more effectively, provide care more accurately, and focus more of their time on patients' needs.

We base this premise on the fact that a clearly legible, unambiguous electronic order does not require additional interpretation and results in fewer callbacks for clarification; callbacks interrupt clinical workflow, potentially increase errors, and decrease patient safety.

This project confirms that CPOE is an effective tool for increasing efficiency in health care. When the same patient care units were compared pre- and post-CPOE, decreases in turnaround time were remarkable. This study confirms the reduction in the time between order placement and the availability of medications for administration, the time for results of radiology procedures, and the time for reporting of laboratory results.

decisions and management. CPOE implementation also requires a new level of integration among all aspects of health care delivery. Order communication is a highly collaborative process, and interdependence in work is a key feature in creating successful computerized ordering systems.[5]

Hallmarks of a successful CPOE system implementation include a high level of leadership involvement, widespread commitment to the project, availability of resources, access to technology, and comprehensive training and communication.[6] If it is viewed simply as a tool for entering test and medication orders, the patient care benefits of CPOE are limited. However, when it is integrated into an organization-wide delivery process, its impact is dramatic.

The improvements in operational efficiency strongly support these efforts. Specifically, clinicians can communicate more effectively, provide care that is more accurate and more timely, and focus more of their time on patients' needs. Although much has been written about using CPOE to reduce medication errors,[7, 8, 9] there is limited published evidence related to clinical efficiency gains with CPOE.[10]

Our purpose was to further delineate those gains. The benefits of CPOE include safer, more consistent patient-centered care that is lasting and measurable. Denver Health has measured turnaround times for laboratory, radiology, and pharmacy as indicators of more rapid communication of results and medication availability as we have implemented CPOE.

Methods

Denver Health Medical Center (Denver Health) is an acute care hospital with over 500 beds that offers a range of inpatient medical, surgical, pediatric, obstetric, and behavioral health services. In 2007, Denver Health recorded over 22,300 inpatient admissions. Denver Health integrates acute hospital and emergency care with public and community health to deliver coordinated preventive, primary, and acute care services. This integration promotes continuity of care for each patient through the entire course of illness. Integration also assures that health care is delivered in the most cost-effective setting.

Beginning in 2003, Denver Health implemented a commercially available CPOE system. Unique features of the system included comprehensive integration with other systems, with bidirectional interfaces to radiology, laboratory, and pharmacy systems; extensive capabilities for customization; and Web-based access.

In order to reach the next level and transform clinically, Denver Health recognized that it needed an integrated systems approach to clinical and nonclinical patient care. Prior to CPOE implementation, a multidisciplinary team evaluated paper-based ordering processes and worked collaboratively to develop approaches incorporating new capabilities offered by computerization of the ordering process. The team recognized that success would involve:

- Enabling existing systems to become 100 percent operational and effectively optimized.
- Improving financial systems' performance with more accurate clinical data.
- Fully implementing clinical systems.

These results mirror to some extent the findings of Mekhjian, et al.,[11] whose methodology for measuring turnaround times differed from that used in this study, in that they measured initiation and completion of orders pre- and post-implementation of CPOE with an electronic medication administration record. Our study did not include an electronic medication administration record. However, they found similar magnitudes of changes, including a 64 percent decrease in medication TATs, a 43 percent decrease in radiology procedure completion times, and a 25 percent reduction in laboratory result reporting times. Similar to our study, their largest improvements occurred in medication TATs, which can potentially have a large effect on patient outcomes for many conditions, such as infectious disease, treatment of elevated blood pressure, pain management, and anticoagulation. These are all conditions where timing of medication administration is particularly crucial.

More recently, Mahoney, et al., reported on the results of implanting an integrated information technology system that included CPOE. They also demonstrated dramatic reductions in medication-related TATs, with an 88 percent reduction, from 90 minutes pre-implementation to 11 minutes post-implementation.[12] Their study differed from ours in that it included barcode-based, point-of-care medication administration across a multihospital health care system with a phased-in approach. By contrast, our study included a single hospital with CPOE, pharmacy and laboratory information systems, clinical decision-support systems, and electronic drug dispensing systems. Their primary endpoint was the reduction in medication errors, with secondary endpoints, such as reductions in medication order TAT and electronic drug dispensing device overrides. Our primary endpoint was the reduction in TATs for laboratory and radiology results and for medication availability.

Health care institutions continue to strive to improve care as it relates to patient safety and quality of care. Increasingly, institutions and organizations are also focusing on the efficiency of health care, realizing that this can affect patient safety and the overall quality of care. The Joint Commission highlighted the importance of efficiency when it defined the important dimensions of performance for quality of care as "patient perspective issues; safety of the care environment; and accessibility, appropriateness, continuity, effectiveness, efficacy, efficiency, and timeliness of care."[13]

Efficiency is considered an important part of three Joint Commission standards: (1) leadership, as it relates to efficient patient flow (standard LD.3.15); (2) management of information (standard IM); and (3) medication management (standard MM). Improvements in turnaround time represent efficiency improvements that can affect overall quality of care.

In addition to improved quality of care, previous studies involving emergency department physicians have found that laboratory TATs are an important component of physician satisfaction and, in their opinion, can influence patients' length of stay and potientially delay treatments.[14] Furthermore, CPOE addresses many deficiencies associated with paper-based ordering. Specifically, CPOE reduces or eliminates:

- The need to locate patients' charts.
- Overlooked orders by nurses or unit secretaries.
- The need for order clarification due to illegibility or poor fax quality.

- The need to manually reenter data, which in turn decreases transcription errors and allows immediate transmission of orders to ancillary services.
- Override rates from electronic drug dispensing systems, ensuring that more orders will be reviewed by a pharmacist.

Although this study demonstrated dramatic improvements in TATs, potential unintended consequences were not monitored. Other studies have described instances where automation of the ordering process has had negative effects, such as an increase in medication errors and actual delays in delivery of care, in contrast to enhanced delivery of care.[15, 16, 17]

However, these findings are countered by the Leapfrog response on CPOE errors,[18] which makes the following points: the primary study of medication error rate increase did not measure error rates prior to CPOE installation; the study compiled impressions and perceptions about problems with just one computer system—one of the oldest in use today; and while introduction of a new computer system can create some errors, it can also reduce overall error frequency.

Conclusion

The benefits of CPOE include safer, more consistent patient-centered care that is lasting and measurable. Efficiencies of the system support better patient safety and quality of care. Our experience demonstrates the importance of efficiency for delivering health care appropriately. At Denver Health, we have demonstrated that CPOE leads to enhanced efficiency by decreasing turnaround times in the ordering process for care related to medication management, as well as laboratory and radiology tests and procedures.

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