Effects of computerized prescriber order entry on pharmacy order-processing time

Jon Wietholter, Susan Sitterson, and Steven Allison

Computerized prescriber order entry (CPOE) has been shown to bestow numerous benefits in the health care setting. Examples of these benefits include increased rates of ordering prophylactic aspirin for patients with coronary artery disease and increased monitoring of drug levels.1,2 Perhaps the most important documented benefit is the reduction in adverse events caused by medication errors.3-5 These benefits help to limit the underuse, overuse, and misuse of health care services, all of which directly influence patient care.6

Despite the documented benefits of CPOE implementation, a 2002 survey found that only 9.6% of U.S. hospitals were utilizing CPOE.7 While this percentage has surely increased since 2002, it is still important to evaluate possible explanations for the overall lack of CPOE implementation. Cost may be a prohibitive factor, as the estimates for implementing CPOE range from roughly $8.0 million, with $1.35 million needed for annual maintenance in a 500-bed hospital, to $11.8 million reduced the order-processing time (from order composition to verification) by 97%. Additionally, pharmacy-specific order-processing time (from order receipt in the pharmacy to pharmacist verification) was reduced by 90%. This reduction in order-processing time improves patient care by shortening the interval between physician prescribing and medication availability and may allow pharmacists to explore opportunities for enhanced clinical activities that will further positively impact patient care.

Conclusion. CPOE implementation reduced the mean pharmacy order-processing time from composition to verification by 97%. After CPOE implementation, a new medication order was verified as appropriate by a pharmacist in three minutes, on average.

Index terms: Computers; Hospitals; Medication orders; Pharmacists, hospital; Pharmacy, institutional, hospital; Physicians; Time studies

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Purpose. The effect of computerized prescriber order entry (CPOE) on the efficiency of medication-order-processing time was evaluated.

Methods. This study was conducted at a 761-bed, tertiary care hospital. A total of 2988 medication orders were collected and analyzed before (n = 1488) and after CPOE implementation (n = 1500). Data analyzed included the time the prescriber ordered the medication, the time the pharmacy received the order, and the time the order was completed by a pharmacist.

Results. The mean order-processing time before CPOE implementation was 115 minutes from prescriber composition to pharmacist verification. After CPOE implementation, the mean order-processing time was reduced to 3 minutes (p < 0.0001). The time that an order was received by the pharmacy to the time it was verified by a pharmacist was reduced from 31 minutes before CPOE implementation to 3 minutes after CPOE implementation (p < 0.0001). The implementation of CPOE

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monitoring of patients into a fully electronic platform.

One aspect of CPOE that may counteract the previously mentioned negative aspects is the expected reduction in medication turnaround time after CPOE implementation. Medication turnaround time is commonly considered the interval from the time a medication order is composed to the time the medication is administered to a patient. A significant component of medication turnaround time is order-processing time—the interval between prescriber composition of an order and pharmacist verification of the order. A reduction in medication turnaround time and adverse events should lead to a direct reduction in health care costs, which would help to offset the expenses of CPOE. One source suggested a $2.7 million annual savings after CPOE implementation. In addition, this reduction in medication turnaround time would allow for an expansion of pharmacists’ clinical skills by creating more time for additional duties (e.g., increased patient-specific monitoring, more extensive exploration of new medication orders). These actions could prevent adverse events and indirectly save health systems money and time that would have been used to evaluate these incidents.

CPOE systems generally reduce medication turnaround time, partially by eliminating medication-ordering steps, such as the transmission of new orders to the pharmacy. There is a lack of definitive data describing the effect of CPOE implementation on this specific aspect of the medication delivery process. One study evaluated 199 orders and found a reduction in mean medication turnaround time from 412 to 318 minutes, a 23% reduction. In addition, composition-to-verification turnaround time was reduced from 94 to 37 minutes, a 61% reduction. Another study evaluated 116 orders and revealed a reduction in medication turnaround time from 328 to 111 minutes, a 64% reduction after CPOE implementation. A third study evaluated orders from only neurosurgery or transplant services and found a reduction in medication turnaround time from 229 to 83 minutes, a 64% reduction. While these studies showed a benefit of CPOE on medication turnaround time, the results have limited generalizability due to inclusion of a small number of orders or evaluation of only certain areas of the hospital. In addition, total medication turnaround time (from order composition to medication administration) was the main aspect evaluated in these studies. Since the process of delivering and administering medications should not change with CPOE implementation, the main benefit realized should be a reduction in order-processing time. The primary objective of this study was to compare the mean order-processing time after converting from a non-CPOE- to a CPOE-based order-processing system by evaluating the time from prescriber order composition to pharmacist order verification.

Methods

Background. This study was conducted at Pitt County Memorial Hospital (PCMH), a 761-bed, tertiary care hospital in Greenville, North Carolina. Approximately 4500 individual medication orders are processed daily by the pharmacy at this facility. Before CPOE implementation, orders were handwritten by prescribers, scanned by nurses into the pharmacy department's order-processing queue, opened electronically by a pharmacist, and clinically evaluated. The pharmacist entered any new medication order into an order-management system if it was deemed appropriate. Once the order was evaluated, the pharmacist could either send the order to the “complete” queue, indicating new items had been entered, or place the order on hold until any necessary clarification could be attained. After implementation of the Healthspan CPOE system (Epic Systems Corp., Verona, WI), at PCMH, new medication orders were electronically entered and signed by a prescriber. They were sent to a medication order queue where they were opened by a pharmacist who would clinically evaluate the order. The pharmacist could either verify the order if it was entered appropriately by the prescriber or place the order on hold until any necessary clarification could be attained. Thus, the step of pharmacist data entry was eliminated as a result of CPOE implementation.

Inclusion criteria. To be included in this study, order sheets composed before CPOE implementation had to contain new medication orders signed and dated by the prescriber who wrote the order and contain the handwritten time of order composition. In addition, either the pharmacist initially evaluating the order and the last person to view the order had to be the same individual, which indicated the completion of the order, or the pharmacist had to specifically indicate the time of completion on the order sheet using electronic documentation.

For orders written before CPOE implementation, only one medication order per scan sequence was used; the intent was to reduce inaccuracies in the calculated order processing time. For the purpose of this study, a scan sequence was defined as a set of new medication orders sent to the pharmacy at the same time. Many scan sequences included multiple medication orders written by the prescriber at the same time. Because medication orders that appeared closer to the top of the page of new orders were more likely to be completed first, the use of all the orders from that one time would skew results since the time completed would be the same for all orders in that scan sequence. The
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The order automatically routed the mixtures were not included, because pharmacist specializing in i.v. ad-
to an inaccurate completion time. This would lead
completed the order was excluded
order was not the pharmacist who
macist who initially viewed the new
around time.
orders were completed the day of
arrival at the hospital. These
elective surgery patient who had ad-
briver’s handwritten time of order-
by the nursing staff preceded the pre-
ten time of ordering or the time the
composed before CPOE implemen-
excluded from this study. Orders
items other than medications were
Exclusion criteria. Orders for
sequence were applied after CPOE
Because medication
orders that appeared near the top of
list of new orders were more
likely to be completed first, using
multiple orders from that set would
skew results. Had multiple orders
from one set been included, the
time ordered would have been the same
because transmission of all orders in
that set occurred at the time of the
prescriber’s electronic signature.

Data collection and analysis. For
orders composed before CPOE im-
plementation, the first 4 orders meet-
ing inclusion criteria from every hour
were examined, except from noon to
1 p.m. where 8 orders were exam-
ined, to create a sample of 100 orders
for each study day. This process was
repeated for 15 consecutive days. The
orders were arranged in order of the
time the order was entered by
physician was then documented. Next,
the “complete queue” was reexamined
to obtain the time the order was scanned
to the pharmacy department. The
time the order was completed by

Results
Of the 1500 orders studied, 1488
met the inclusion criteria for the
preimplementation group. Twelve
orders were excluded because the
handwritten time on the order was
later than the time the order was

Statistical analysis. A sample
size calculation indicated that 1194
orders would be needed in the post-
implementation group to determine
a 15-minute overall reduction in pharmacy-specific turnaround time with a two-tailed \( \alpha \) of <0.05 and
90% power. Ninety-five percent
confidence intervals were computed.
Mean and standard deviation times
were compared between orders
composed before and after CPOE
implementation using an unpaired
Student’s \( t \) test to evaluate continu-
ous variables.
taken no time, the mean mission to the pharmacy essentially to the time the order was completed scanned to the pharmacy department was 84 ± 191 minutes for these orders. The mean ± S.D. time from when the order was scanned to the pharmacy department to the time the order was completed by a pharmacist was 31 ± 116 minutes. Thus, the mean ± S.D. overall order-processing time from prescriber composition to pharmacist verification was 115 ± 225 minutes before CPOE implementation.

In the postimplementation order group, 1500 orders met inclusion criteria and were analyzed. Since the prescriber directly entered medication orders into the order-processing system, the step involving scanning orders to the pharmacy was eliminated. The mean ± S.D. time from when the order was electronically signed and transmitted to the pharmacy department to pharmacist completion was 3 ± 8 minutes. Since transmission to the pharmacy essentially took no time, the mean ± S.D. overall order-processing time from order composition to pharmacist verification was also 3 ± 8 minutes. CPOE was thus associated with a 97% reduction in time from composition to verification \((p < 0.0001)\) and a 90% reduction in time from pharmacy receipt of the order to its completion by a pharmacist \((p < 0.0001)\).

Discussion

This study evaluated the processing time for new medication orders before and after CPOE system implementation. Due to the elimination of the step involving the time between prescriber composition and scanning of written orders to the pharmacy, a drastic reduction in order-processing time was assumed. Before CPOE implementation, nurses had to be aware that a prescriber had written a new medication order. The nurse would then have to remove the order from the chart to scan to the pharmacy. This placed the new medication order in the pharmacist’s order queue. Since nurses have numerous patient care responsibilities, the receipt of new orders by the pharmacy could be significantly delayed. The data collected in this study indicate that the average order was not received in the pharmacy until 84 minutes after composition. The elimination of this step contributed to the 97% reduction of the overall composition-to-verification time. Before this study, it was hypothesized that the time of pharmacy order receipt to order verification by a pharmacist would be reduced by 15 minutes, a 50% reduction after CPOE implementation. There was in fact a 90% reduction in pharmacy-specific medication-order-processing time between the preimplementation and postimplementation time frames. The mean pharmacy-specific medication-order-processing time was reduced by 28 minutes.

Decreased order-processing time has directly affected patient care. On average, medications are available 112 minutes sooner than they were before CPOE implementation. This allows earlier access to medications that are needed more urgently (e.g., pain medications, antiemetics, sedatives for combative patients). With earlier access comes earlier availability of medications to patients, which increases the satisfaction of patients and employees regarding the time spent in the hospital.

While this study showed a definitive benefit on order-processing time after CPOE implementation, it was not without limitations. First, although orders composed before CPOE implementation required a handwritten time, it was impossible to tell whether that time was the prescriber’s estimate or the actual time of order composition. Further, using only one medication on each order may have skewed the completion time. An example of this would be a scan sequence containing 8 medication orders with 7 written correctly and 1 needing clarification. Although correct medication orders were processed, the scan sequence was not noted to be complete until every medication order in the scan sequence was clarified. This may have falsely prolonged order-processing time. Another limitation was the inclusion of orders entered by pharmacists as oral orders from the providers. When a prescriber called in an oral order to a pharmacist, the order was likely processed immediately, which may have falsely shortened the order-processing time. In addition, the results showed widespread variation in the time taken to complete the order-processing sequence, which was signaled by large standard deviations. This was likely due to the inclusion of all types of new medication orders, including stat orders, as well as orders that took upward of 24 hours to receive an appropriate clarification about their accuracy. Another limitation was that a mass quantity of orders was not evaluated. Only 100 of approximately 4500 orders were evaluated daily, so the possibility exists that results would have been different if a greater percentage of daily orders had been evaluated. Despite these limitations, it is felt that a representative sample of orders was used to complete the study.

The results of this study warrant the discussion of an additional aspect of the medication use process. The Joint Commission requires pharmacist review of all medication orders unless a delay in order processing would significantly compromise patient care. If an ordered medication is stored in an automated dispensing cabinet (ADC), it is available for withdrawal by the individuals directly caring for the patient immediately after pharmacist verification. However, certain medications are deemed emergent, and nurses can immediately remove these medications before pharmacist verification. This study suggests that the list of
medications available for immediate nurse removal from an ADC without pharmacist review could be reduced. An average order composition-to-verification time of three minutes indicates that any medication not deemed lifesaving can be removed from the list of medications available without pharmacist review. This will create a safer environment for the patient, as a pharmacist will evaluate the appropriateness of more medication orders before administration to the patient.

Conclusion

CPOE implementation reduced the mean pharmacy order-processing time from composition to verification by 97%. After CPOE implementation, a new medication order was verified as appropriate by a pharmacist in three minutes, on average.

References