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Effect of a Computerized Provider Order Entry (CPOE) System on Medication Orders at a Community Hospital and University Hospital

Mark L. Wess, MD, SM,[1,2,3] Peter J. Embi, MD, MS,[1,2] James L. Besier, PhD,[3] Chad H. Lowry, PharmD,[3] Paul F. Anderson, MBA,[3] James C. Besier,[3] Geriann Thelen, RN,[3] and Catherine Hegner, RN, MSN[3]

[1]Division of General Internal Medicine, University of Cincinnati, Cincinnati, OH
[2]Center for Health Informatics, University of Cincinnati, Cincinnati, OH
[3]Health Alliance of Greater Cincinnati, Cincinnati, OH

Abstract

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Computerized Provider Order Entry (CPOE) has been demonstrated to improve the medication ordering process, but most published studies have been performed at academic hospitals. Little is known about the effects of CPOE at community hospitals. With a pre-post study design, we assessed the effects of a CPOE system on the medication ordering process at both a community and university hospital. The time from provider ordering to pharmacist verification decreased by two hours with CPOE at the community hospital ($p<0.0001$) and by one hour at the university hospital ($p<0.0001$). The rate of medication clarifications requiring signature was 2.80 percent pre-CPOE and 0.40 percent with CPOE ($p<0.0001$) at the community hospital. The university hospital was 2.76 percent pre-CPOE and 0.46 percent with CPOE ($p<0.0001$). CPOE improved medication order processing at both community and university hospitals. These findings add to the limited literature on CPOE in community hospitals.

INTRODUCTION

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Few hospitals have implemented Computerized Provider Order Entry (CPOE). KLAS Enterprises LLC and others estimate six percent of US hospitals have some form of CPOE, whereas the Leapfrog Group estimates ten percent.(1, 2) Most published CPOE studies relate to academic medical centers, with few addressing the effect on community hospitals.(3–6) Moreover, community hospitals account for about 89 percent of U.S. hospitals and most of the physicians are not employed by the hospital. CPOE is a large, expensive change for providers and hospitals. It can improve medication safety and timely delivery of care, resulting in improved patient outcomes, reduced cost, and decreased length of stay.(3)

Some studies have looked at medication order processing time and calls for medication clarification, but are largely academic institutions. Evaluation of the CPOE implementation at Ohio State University Medical Center reported on turnaround times, length of stay and cost. They found decreases in medication, radiology, and laboratory times. Specifically, medication turnaround time decreased 64 percent, 5:28 hours to 1:51 hours for ordering to medication administration.(7) Similarly, Montefiore Medical Center looked at a medication turnaround time from ordering to medication arrival on the floor. The pilot unit went from 245 minutes before CPOE to 20 minutes with CPOE.(8)

Many more studies have looked at adverse drug events with close to 50 percent of medication errors linked to the physician ordering process.(9) CPOE has been touted as reducing these events by 55 to 80 percent.(10–12) As an example, Montefiore Medical Center, using the same commercial system as this study, demonstrated a 50 percent reduction in prescribing errors.(8) Another study, using an automated surveillance system, found 4.4 adverse drug events per 100 admissions at a university hospital, while 6.2 per 100 admissions were found at the community hospital.(13) While CPOE can improve processes, fewer studies have demonstrated it can cause harm and some errors can persist.(14–17)

Given the known impacts of CPOE in the settings studied to date, our hypothesis was that the results of CPOE implementation on medical ordering processes would be similar for a community hospital and a university hospital. To test this hypothesis, we chose to focus on two segments of the medication process that CPOE directly impacts: 1) the time from provider order entry to pharmacist verification and 2) the proportion of clarification calls placed by pharmacists to ordering providers. To our knowledge, this is the first study of its kind to compare these parameters following simultaneous use of the same commercial CPOE system at both a community and a university hospital.

METHODS

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Setting: In 2004, The Health Alliance of Greater Cincinnati, a group of six hospitals serving the greater Cincinnati region, embarked on a CPOE implementation effort at two of its hospitals as part of the ongoing quality improvement efforts. The Elizabeth Gamble Deaconess Home Association, the founding organization of The Christ Hospital - a Health Alliance hospital, funded the installation of inpatient CPOE at both The Christ and University Hospitals. GE, formerly IDX, LastWord® is the hospital information system (HIS) used at all facilities. It has been used for order management since 1998. The system was tailored and processes redesigned for CPOE use. The pilot units were an orthopedic/neurosurgery unit at a community hospital and a general surgery unit at a university hospital. They implemented CPOE on June 6, 2005 and September 7, 2005 respectively. At the community hospital, “universal” use was encouraged, whereas use was required at the university hospital.

The two environments differed significantly in that the community hospital’s patients had orders entered by staff physicians or physician assistants. At the university hospital, the majority of orders were entered by housestaff (residents and fellows) or medical students. In both settings, adopting CPOE was a significant undertaking, requiring extensive resources, process, and cultural changes.

Measures:

Time from Medication Ordering to Pharmacist Verification Benchmark data were collected in the two months before CPOE implementation (pre-CPOE). Trained observers followed physicians on the units and captured new orders as they were written. They collected information on the date, time, medication ordered, and order sessions. Order

sessions were defined as a group of orders placed as part of a care event and then submitted for processing. During the observation period, all medication orders were able to be captured. The pharmacist verification time was collected from the HIS as the time the pharmacist entered the medication order into the system, simultaneously verifying it. After CPOE implementation, data were collected from the date and time stamps from the HIS provider, nurse, or PA order entry and pharmacist verification audit trails for nine months. Written orders during CPOE were excluded from analysis.

Medication Clarification Calls Requiring Signature Benchmark data were collected for four months before CPOE implementation (pre-CPOE). All paper medication clarification forms from each hospital, during the time period, were reviewed. We identified and copied those from the pilot units. After CPOE implementation, data were collected from the HIS. Medication clarification calls requiring CPOE signature, were defined as a verbal or telephone order and entered by the pharmacist. We also included medications entered in CPOE as "written" where comments indicated that they were medication clarifications. As part of the CPOE process, pharmacists were to enter reasons for the medication clarification in the intervention comments of the telephone order. Information on the paper clarification form and the intervention comments on the electronic order were used to determine the reason for the order requiring signature. CPOE data were collected for nine months. For the hospital unit of interest, medication order volume was determined by the number of medication orders in the system during the data collection time periods. For CPOE, we excluded written orders, since these clarifications should be written on forms as per pharmacy procedures.

While other factors also contribute to the actual medication distribution and administration time, we did not expect CPOE to significant affect these times beyond our study's focus. Therefore, with limited resources, we did not formally evaluate these during this study.

Data Analysis: Medication order volume fluctuates based upon the day of the week and time of day. To minimize the effect of order volume fluctuations and pharmacist staffing, we compared the same day of the week and time of day for the pre-CPOE data to the same time frame for the CPOE data. Mean time from order entry to pharmacist verification was calculated for each block. The overall mean time was then calculated. A Student's T test was used to compare means for pre- and CPOE. Results were the same whether compared at the matched observation time period or overall mean. For medications requiring callback and signature, two independent reviewers validated that the observation was a clarification resulting in a callback. Each further classified it by the reason for the callback. One order could have multiple reasons. We calculated rates by counting each medication listed once, divided by the total medication order volume. A Student's T test was used to compare callback rates pre- and CPOE for each facility.

RESULTS

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We observed 709 medication order instances using the baseline paper order process pre-CPOE, and 3,082 CPOE-entered orders post-implementation. The number of orders did not differ significantly between the community and university hospitals.

At the community hospital, the mean time from ordering to pharmacist verification decreased by two hours, from 2 hours 32 minutes pre-CPOE to 32 minutes using CPOE ($p<0.0001$) (Table 1). By comparison, the university hospital baseline process was faster at baseline, and saw a mean time decreased of about 1 hour, from 1 hour 48 minutes pre-CPOE to 50 minutes using CPOE ($p<0.0001$) (Table 1). Fewer medication orders per week were placed in CPOE due to some complex medication orders (e.g. TPN) that were still handwritten and because some

targeted providers continued to write paper orders despite being encouraged to use CPOE. These results remained statistically significant when analyzed by order session or matched by day or week.

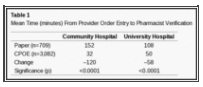

Table 1

Mean Time (minutes) From Provider Order Entry to Pharmacist Verification

The results of reviewing medication clarification order sheets for the initial CPOE unit found 133 clarification calls requiring signature at the community hospital, compared with 23 using CPOE. The rate of calls resulting in orders requiring signature was 2.80 percent for pre-CPOE and 0.40 percent for CPOE ($p<0.0001$) (Table 2). Similarly, the university hospital had 106 clarification calls requiring signature, compared with 34 using CPOE. The rate of calls resulting in orders requiring signature was 2.76 percent for pre-CPOE and 0.46 percent for CPOE ($p<0.0001$). After additional units went live on CPOE at the facilities, the mean times for these units decreased further. The calls with CPOE were distributed over the nine-month observation period. We did not capture those calls made to physicians pre- or CPOE that did not result in an order requiring signature.

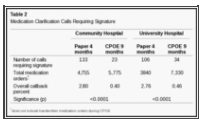

Table 2

Medication Clarification Calls Requiring Signature

The reasons for many of the medication clarification calls were the result of missing information or unclear handwriting, as demonstrated in Table 3. Of the 133 handwritten orders at the community hospital, 87 (65%) were the result of dose, medication, frequency or route clarifications. Similarly, at the university hospital, 74 of the 106 (70%) of the clarifications were attributed to those reasons. These types decreased markedly with CPOE. Non-formulary calls also decreased. In CPOE, the non-formulary medications were labeled as such on the selection lists. Therapeutic interchanges were labeled and occurred automatically when selected. While the CPOE system provides drug-allergy and drug-drug interaction checking, these types of clarifications did not decrease as part of this study. Users did complain about the number of alerts presented using CPOE.

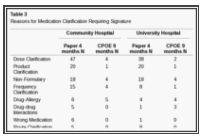

Table 3

Reasons for Medication Clarification Requiring Signature

DISCUSSION

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CPOE systems have been shown to have significant impacts on ordering processes when studied in academic settings. We simultaneously compared the ordering process pre-CPOE and after implementation on the same units at a community and university hospital using the same commercial CPOE system. Based upon our results, the medication processing time was significantly reduced by two hours for the community hospital and one hour for the university hospital. For this component of the order management process, we expected to see improved efficiencies, since multiple steps were eliminated with CPOE. Anecdotally, nursing staff on the units relayed that medications were arriving to the floor or listed in patient's PYXIS profile more quickly. In some instances, the first time a nurse was aware of the new medication was when the medication was delivered to them. Unexpectedly, the community hospital had greater paper order processing time and the time improved more

dramatically with CPOE than the university hospital. These time study results suggest that a community hospital is likely to benefit as much as an academic medical center hospital from medication order processing efficiency due to immediate communication of orders to the pharmacy.

Medication clarification calls delay patient care and result in increased time required by physicians, pharmacists and nurses. The types and frequency of the reasons for medication calls was similar for the community and university hospitals (Tables 2 and 3). Interestingly, CPOE had a similar effect at reducing those calls at both facilities by six fold or greater. The system has required fields that prevent incomplete orders from processing. Through medication order design where complete information of medication name, dose, route and frequency are pre-specified, we further reduce the likelihood of incomplete or incorrect orders. Medication product clarifications results from legibility, product type or strength not included, or duplicate orders. CPOE eliminates legibility issues and all medication orders are product specific in the system used. Drug duplicate alerts were displayed, but not always addressed. Similarly, the drug-allergy and drug-drug interaction alerts did not change, likely due to alert fatigue. Due to significant educational efforts, we did not see many unapproved dose or name annotations as was seen by pharmacy at the start of the study design. Consequently, few occurred with the paper orders and none occurred with CPOE.

To augment the findings of this study, we surveyed physicians, residents, and nurses pre- and post-CPOE implementation. These findings are presented elsewhere in these proceedings. While satisfaction was variable, physician leadership at both facilities was presented with the information and continued with the implementation.

This study validates that the same vendor system can improve the medication ordering process at both community and university hospitals. This improvement comes at the cost of increased ordering time for the provider, which is less tolerated by independent physicians To our knowledge, this is the first such study to simultaneously compare these impacts of CPOE in a community and university hospital, and it provides some insights into the impacts of CPOE that should be of interest to those working in this domain. Further studies are needed on CPOE's other effects on community hospitals.

LIMITATIONS

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The initial units at both hospitals were surgical; therefore the ability to generalize to all units may be limited. While efforts were made to have universal use of CPOE on the units, some providers continued to handwrite orders on the unit at the community hospital, resulting in a hybrid of paper and CPOE orders. The community hospital also had physician assistants placing some of the orders. Sufficient orders were entered by the physicians and written orders were excluded from the CPOE analysis. Additionally, the time for medication verification in the paper order process is heavily dependent upon staff availability for order processing and communication to pharmacy. This staffing is different across units and time of day. The observed times were only weekdays. The observed activities were at a time when the most unit staff was available and would bias toward the paper ordering process. The medication clarifications are heavily dependent upon pharmacist documentation in both order processes. If the pharmacist did not document the reason or send for signature, then the number of calls could be underreported. Since the CPOE process was re-enforced multiple times during the time period, we expected the documentation with CPOE to be equal to or better than the handwritten process. A Hawthorne effect is also possible. Pharmacists could be more vigilant with the new CPOE ordering process with documentation and processing. Since the time improved with additional CPOE volume, we expect this had a minimal effect on the time results. For the clarification calls, it would have biased the results toward the paper process. Therefore,

the improvement would be even larger if it was having an effect. Lastly, while there are other affects we would have liked to measure (adverse events, length of stay, etc.); limited resources precluded such measurement during this study.

CONCLUSION

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At the Health Alliance of Greater Cincinnati, we have demonstrated that CPOE improves efficiency in the medication order processing at both the community hospital and a university hospital, specifically the time from medication ordering to pharmacist verification. Medication clarifications requiring signature were reduced 6–7 fold with CPOE compared with handwritten orders at both hospitals. Most CPOE studies are on academic medical centers and this study suggests that the effects of CPOE may be similar for community hospitals.

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