Original Article

Impact of Computerized Provider Order Entry on Pharmacist Productivity

Mark D. Hatfield, MS^{*}; Rodney Cox, RPh, MS[†]; Shivani K. Mhatre, MS[‡];
W. Perry Flowers, RPh, MS[§]; and Sujit S. Sansgiry, PhD[¶]

Abstract

Purpose: To examine the impact of computerized provider order entry (CPOE) implementation on average time spent on medication order entry and the number of order actions processed.

Methods: An observational time and motion study was conducted from March 1 to March 17, 2011. Two similar community hospital pharmacies were compared: one without CPOE implementation and the other with CPOE implementation. Pharmacists in the central pharmacy department of both hospitals were observed in blocks of 1 hour, with 24 hours of observation in each facility. Time spent by pharmacists on distributive, administrative, clinical, and miscellaneous activities associated with order entry were recorded using time and motion instrument documentation. Information on medication order actions and order entry/verifications was obtained using the pharmacy network system.

Results: The mean $\pm$ SD time spent by pharmacists per hour in the CPOE pharmacy was significantly less than the non-CPOE pharmacy for distributive activities (43.37 ± 7.75 vs 48.07 ± 8.61) and significantly greater than the non-CPOE pharmacy for administrative (8.58 ± 5.59 vs 5.72 ± 6.99) and clinical (7.38 ± 4.27 vs 4.22 ± 3.26) activities. The CPOE pharmacy was associated with a significantly higher number of order actions per hour (191.00 ± 82.52 vs 111.63 ± 25.66) and significantly less time spent (in minutes per hour) on order entry and order verification combined (28.30 ± 9.25 vs 36.56 ± 9.14) than the non-CPOE pharmacy.

Conclusion: The implementation of CPOE facilitated pharmacists to allocate more time to clinical and administrative functions and increased the number of order actions processed per hour, thus enhancing workflow efficiency and productivity of the pharmacy department.

Key Words—computerized provider order entry, CPOE, order action, order entry, pharmacist productivity, time and motion

Hosp Pharm—2014;49(5):458–465

Computerized provider order entry (CPOE) has been rapidly adopted throughout the United States in recent years, due to the documented benefits of decreasing medication errors.^{1–3} This trend can be traced to the landmark publication on the

quality of health care in America, *To Err is Human*, in 1999, in which the scale of medication errors was brought to light.⁴ More recently, the Health Information Technology for Economic and Clinical Health Act (HITECH) of 2009⁵ was passed as a measure to

^{*}Research Assistant, Department of Pharmaceutical Health Outcomes and Policy, University of Houston, College of Pharmacy, Houston, Texas; [†]Operations Manager, Memorial City Medical Center, Memorial Hermann Healthcare System, Houston, Texas; [‡]Teaching Assistant, Department of Pharmaceutical Health Outcomes and Policy, University of Houston, College of Pharmacy, Houston, Texas; [§]Vice President, Acute Care and Infusion Pharmacy Programs, Kaiser Permanente, Downey, California; [¶]Associate Professor, Department of Pharmaceutical Health Outcomes and Policy, University of Houston, College of Pharmacy, Houston, Texas. Corresponding author: Sujit S. Sansgiry, PhD, Associate Professor, Department of Pharmaceutical Health Outcomes and Policy, University of Houston, College of Pharmacy, 1441 Moursund Street, Houston, TX 77030; phone: 713-795-8392; fax: 713-795-8383; e-mail: ssansgiry@uh.edu

aid with improving patient outcomes and ultimately to reduce health care costs with the implementation of technological efficiencies. It brought about incentives for hospitals to implement electronic health records (EHRs) with “meaningful use” through the Centers for Medicare & Medicaid Services (CMS).⁶

Despite this trend, according to the Healthcare Information and Management Systems Society Analytics Database, as of the fourth quarter of 2013, there are still 47% of hospitals in the United States that are not compliant with stage 4, which includes the implementation of a CPOE system with meaningful use.⁷ This implies that there are still many hospitals that have not yet transitioned fully into CPOE systems.

Pharmacy leadership has to reexamine departmental workflow and utilization of labor at all stages of the medication use process to be productive. As order entry gives way to order verification, various assumptions of cost savings in pharmacy labor and the function of pharmacists engaged in order processing have been put forth by hospital leadership and clinicians. Anecdotal stories of physicians questioning the role of pharmacists in the medication use process once they take over order entry, a role traditionally filled by pharmacy, are shared among colleagues preparing for CPOE deployment in their respective facilities.⁸ Pharmacy administration must look not only to the purported outcomes that the technology produces, but also to the impact and potential disruption of the processes associated with CPOE deployment within the pharmacy.

This study seeks to identify the impact of CPOE on the workflow of pharmacists, particularly those engaged in the transcription phase of the medication use process or order entry. We will examine the effect of CPOE on time spent on major activities associated with order entry, namely distributive, administrative, clinical, and miscellaneous.

METHODS

Study Design and Data Collection

A prospective observational time and motion study was conducted from March 1 to March 17, 2011 to determine the effects of the implementation of CPOE with respect to pharmacists' time. The study was approved by the university's institutional review board (IRB). Formal approval was granted by the hospital's pharmacy administration.

Pharmacists whose primary responsibility was order entry were observed in 2 separate facilities at the Memorial Hermann Healthcare System in

Houston, Texas. The first facility was the Memorial Hermann Southeast Hospital (274 beds), which had implemented a CPOE system approximately 7 months prior to observation. The second facility was the Memorial Hermann Northwest Hospital (238 beds), which had not yet implemented a CPOE system. The hospitals were chosen based on their similar structure and size.

Both hospitals shared the same information technology (IT) structure. Cerner Millennium (Cerner Corp., Kansas City, MO) was used to exchange health information, and pharmacy order entry was supported by PharmNet (a Cerner application). CPOE orders were transmitted in real time and were available in PharmNet for pharmacist verification. Pyxis Connect (CareFusion Corp., San Diego, CA) provided medication order management for written orders. All orders, both CPOE and non-CPOE, were entered into PharmNet.

All observations took place in the central pharmacy department within the selected hospitals. The same data collection instrument and collector were used at both locations to minimize bias. The central inpatient pharmacy at both locations was open 24 hours a day, 7 days a week. Observations occurred during the morning shift, from 7:00 a.m. to 3:00 p.m., Monday through Friday. This shift was selected due to the relatively large and steady volume of incoming orders to each pharmacy. Due to the greater volume during this work shift, a greater number of pharmacists were working, and therefore a greater amount of variation among the pharmacists could be observed. Each hour was considered an observational unit. One pharmacist was observed during each 1-hour unit. It was determined a priori that each 1-hour observation would be repeated 3 times over a 5-day period (eg, the hour from 8:00 a.m. to 9:00 a.m. was observed on Monday, Wednesday, and Thursday, and so on for each pharmacy). This minimized the error associated with observing a particular time slot on any given day of the week. At each facility, 24 one-hour observational units were conducted, totaling 48 hours.

Only pharmacists whose primary responsibility was order entry were included in the study. Pharmacists whose responsibility was not primarily order entry (eg, clinical pharmacists, administrative pharmacists) and order entry pharmacists who were mentoring or teaching new pharmacists or students were excluded. Pharmacists were randomly chosen for each hour of observation to minimize bias and account for variation in work style. Prior to the start of the observations, all observed pharmacists were informed of

the purpose of the study and were given a consent form, detailing the voluntary nature of the study and confirming anonymity of each potential subject.

The data collector observed the pharmacists from behind their workstations at a distance from which all activities could be seen while posing no obstruction to the order entry team. The data collector was a hospital pharmacist with over 10 years of experience in order entry. The data collector recorded all observations on a laptop using an instrument developed to capture time for various tasks. To minimize the Hawthorne effect and allow workflow to proceed in a normal fashion, the data collector practiced using the instrument for several days at each pharmacy. During the actual data collection, the data collector was positioned in such a way that pharmacists were unaware as to exactly when the data collection was initiated and stopped. All efforts were made not to interact with pharmacists once observations had begun.

The time and motion instrument was developed in Access (Microsoft Corp., Redmond, WA). The instrument was created by Partners Healthcare System for the Agency for Healthcare Research and Quality (AHRQ) and was designed to capture and store time and motion data for analysis.⁹ The major activities and tasks were removed from the original template and replaced with actions that mirrored pharmacist workflow. Through personal interviews of order entry pharmacists, clinical pharmacists, and pharmacy managers, 30 different tasks of the order entry pharmacist were identified and validated. These tasks were further grouped into 4 major activities: (1) distributive (13 tasks), (2) administrative (6 tasks), (3) clinical (7 tasks), and (4) miscellaneous (4 tasks). These were outlined previously and alluded to in a previous study.¹⁰

The PharmNet system provided data on the number of order actions and order entry/verifications performed by the entire pharmacy for each hour of observation to gauge the relative productivity between the CPOE and non-CPOE pharmacies. An order action was defined as any action conducted in PharmNet pertaining to pharmacy orders, including order entry/verification, modify, discontinue, delete, hold, renew, or reschedule. Order entry/verification was defined as a completed order. Order entry, for the purposes of this article, was defined as performing any order action for an order scanned (non-CPOE) into PharmNet by a pharmacist. Order verification was defined as the process of performing any order action for a CPOE order.

Baseline data were recorded during each hour of observation, including the pharmacist (by code), pharmacist's gender, pharmacist's institutional experience in months, pharmacist's education, number of pharmacists assigned to order entry, and number of pharmacy technicians on duty.

Statistical Analysis

Data collected by the instrument were exported to an Excel (Microsoft Corp., Redmond, WA) spreadsheet, where they were subsequently exported to SAS version 9.2 (SAS Institute Inc., Cary, NC) for descriptive statistics and statistical analysis. The means of the combined time spent for each observational hour per activity and per task, by pharmacy, were calculated. For each observational hour that did not have a value for a particular activity or task, a value of zero was used. Comparisons of the number of order actions and the order entry/verifications were calculated on a pharmacy-wide basis for the hours observed. Wilcoxon rank sum tests were performed, and a statistical significance was set at an alpha of 0.05.

RESULTS

Of the 48 hours observed, 47 met the inclusion criteria, yielding 23 hours at the CPOE pharmacy and 24 hours at the non-CPOE pharmacy. A total of 1,685 different observations were collected, and 896 were from the CPOE pharmacy.

Table 1 describes the baseline characteristics of the 2 pharmacies. Eleven pharmacists were observed, and 91% were female. The CPOE pharmacists had far less mean and total months of institutional experience, but more of them had PharmD degrees. The mean number of technicians and pharmacists present in the central pharmacy during the observation period was equal in both pharmacies. Clinical pharmacists were not included in these figures.

The mean time spent by the pharmacist across the 4 activities is shown in **Table 2**. The majority of pharmacist time was spent in the distributive activity; this was approximately 72% for the CPOE pharmacy (997.42 minutes) and 81% for the non-CPOE pharmacy (1,153.61 minutes). For the CPOE pharmacy, the administrative activity used the next greatest amount of pharmacist time (14%), then clinical (12%), followed by the miscellaneous activity (2%). The non-CPOE pharmacists spent more time with administrative tasks (approximately 10%), then clinical (7%), followed by miscellaneous (3%). Approximately 68 more minutes of elapsed time was observed

Table 1. Baseline characteristics of hospital pharmacies: CPOE vs non-CPOE pharmacies

Characteristic	CPOE	Non-CPOE
Pharmacists in cohort, <i>n</i>	6	5
Female pharmacists/total pharmacists, <i>n</i> (%) ^a	5/6 (83)	5/5 (100)
Institutional experience of pharmacist in months, mean, <i>n</i> ± <i>SD</i> ^b	49 ± 42	281 ± 125
Pharmacists with PharmD degree/total pharmacists, <i>n</i> (%) ^c	5/6 (83)	0/5 (0)
Order entry pharmacists on duty, mean (range)	3 (2-4)	3 (2-3)
Pharmacy technicians on duty, mean (range)	5 (3-6)	5 (3-5)

Note: CPOE = computerized provider order entry.

^a*P* = 1.000 using Fisher's exact test. *P* < .05 is considered statistically significant.

^b*P* < .001 using Wilcoxon rank sum test. *P* < .05 is considered statistically significant.

^c*P* = .015 using Fisher's exact test. *P* < .05 is considered statistically significant.

Table 2. Mean time (min/h) for pharmacist order entry activities: CPOE vs non-CPOE pharmacies

Activity	Mean, minutes per hour ± <i>SD</i>		<i>P</i> ^a
	CPOE	Non-CPOE	
Distributive	43.37 ± 7.75	48.07 ± 8.61	.037
Administrative	8.58 ± 5.59	5.72 ± 6.99	.020
Clinical	7.38 ± 4.27	4.22 ± 3.26	.006
Miscellaneous	0.93 ± 1.17	1.63 ± 1.92	.314

Note: CPOE = computerized provider order entry.

^a*P* calculated using Wilcoxon rank-sum test. *P* < .05 is considered statistically significant.

in the CPOE group under the clinical activity, despite having only 23 hours of observations versus the non-CPOE group with 24 hours of observations. There was a statistically significant difference between the CPOE and non-CPOE pharmacies with regard to the time spent across the distributive, administrative, and clinical activities (Table 2).

When the 30 individual tasks were evaluated based on time spent, 5 were found to be statistically significant: order entry, other-distributive, question and answer with pharmacy management, phone triage, and electronic medication administration record (eMAR)/lab review. The summary of each task is shown in Table 3, which relates the mean time (minutes per hour) for each observation and the number of times the task was observed.

The number of minutes per hour spent on order entry was significantly less (*P* = .003) for the CPOE pharmacy (26.96 ± 9.07) as opposed to the non-CPOE pharmacy (36.27 ± 9.01). The number of minutes per hour spent on order entry and order verification combined was significantly less (*P* = .008) for the CPOE pharmacy (28.30 ± 9.25) as opposed to the non-CPOE pharmacy (36.56 ± 9.14). The num-

ber of different tasks performed by the pharmacists per hour was significantly higher (*P* = .010) for the CPOE group (35.35 ± 9.99) versus the non-CPOE group (27.00 ± 11.24).

More nurse clarifications (communications initiated by pharmacists with nurses regarding clarifications of orders) and medication requests by nurses were observed for the non-CPOE group (49 vs 27) than for the CPOE group (37 vs 23). eMAR/lab review occurred at a rate of over 2 to 1 with the CPOE group (58 CPOE vs 24 non-CPOE). More clinical intervention documentation was observed in the CPOE group (7) than for non-CPOE (2). Direct patient care was observed on 3 separate occasions for the CPOE pharmacy versus none for the non-CPOE pharmacy.

The productivity data taken from the PharmNet system yielded significant results as well. A total of 4,393 order actions were extracted from the data system at the CPOE pharmacy, of which 2,628 were order entry/verifications (60% of the total). In comparison, 2,679 order actions were recorded in the non-CPOE group, of which 1,973 were recorded as order entry/verifications (74% of the total). The mean ± *SD* order actions per hour for the CPOE and non-CPOE groups were 191.00 ± 82.52 and 111.63 ± 25.66, respectively (*P* < .001). The mean ± *SD* order entry/verifications per hour for the CPOE and non-CPOE groups were 114.26 ± 42.96 and 82.21 ± 18.63, respectively (*P* < .001).

DISCUSSION

Statistical analysis of the 4 major activities captured by the time and motion instrument yielded significant findings in 3 activities: distributive, administrative, and clinical. Quantitative differences in the total elapsed time of the 4 major activities are suggestive of efficiencies gained post CPOE;

Table 3. Mean time (min/h) pharmacist order entry tasks: CPOE vs non-CPOE pharmacies

Task (by activity)	Mean, minutes per hour $\pm$ SD (total no. of tasks)		<i>P</i> ^a
	CPOE	Non-CPOE	
Distributive			
Order entry	26.96 $\pm$ 9.07 (317)	36.27 $\pm$ 9.01 (356)	.003
Tech check, non-IV room	6.67 $\pm$ 7.45 (77)	2.56 $\pm$ 3.29 (39)	.055
Clarification, nurse	2.04 $\pm$ 2.63 (27)	2.47 $\pm$ 2.36 (49)	.265
Medication preparation	1.69 $\pm$ 7.41 (9)	0.08 $\pm$ 0.32 (2)	.567
Tech check, IV room	1.42 $\pm$ 2.99 (17)	1.15 $\pm$ 2.10 (16)	.617
Order verification	1.34 $\pm$ 3.14 (17)	0.29 $\pm$ 0.87 (3)	.133
Medication request, nurse	1.21 $\pm$ 1.83 (23)	2.62 $\pm$ 3.26 (37)	.204
Answer dispensing questions	1.10 $\pm$ 2.06 (26)	1.31 $\pm$ 2.03 (28)	.524
Other, distributive	0.37 $\pm$ 1.39 (3)	0.91 $\pm$ 1.58 (13)	.013
IT support	0.32 $\pm$ 0.88 (4)	0.31 $\pm$ 0.70 (7)	.617
Medication delivery	0.24 $\pm$ 0.40 (7)	0.10 $\pm$ 0.32 (3)	.156
Clarification, physician	0	0	N/A ^b
Medication request, technician	0	0	N/A ^b
Administrative			
Q & A with pharmacy management	4.21 $\pm$ 3.95 (114)	0.81 $\pm$ 1.01 (27)	.001
E-mails	1.17 $\pm$ 2.55 (20)	0.86 $\pm$ 2.23 (10)	.461
Other, administrative	0.96 $\pm$ 1.77 (21)	3.33 $\pm$ 5.65 (56)	.056
Phone triage	0.92 $\pm$ 0.94 (38)	0.08 $\pm$ 0.26 (4)	<.001
Meeting	0.86 $\pm$ 2.11 (11)	0.65 $\pm$ 1.81 (12)	.814
Shift report	0.45 $\pm$ 1.48 (6)	0	.160
Clinical			
eMAR /lab review	2.45 $\pm$ 2.25 (58)	0.75 $\pm$ 1.24 (24)	.002
Medication therapy recommendation	2.13 $\pm$ 3.36 (26)	1.82 $\pm$ 1.98 (32)	.796
Drug information	1.78 $\pm$ 2.27 (36)	1.49 $\pm$ 2.61 (28)	.377
Other, clinical	0.43 $\pm$ 1.88 (4)	0.04 $\pm$ 0.14 (2)	.913
Clinical intervention, documentation	0.29 $\pm$ 0.63 (7)	0.11 $\pm$ 0.43 (2)	.204
Direct patient care	0.22 $\pm$ 0.90 (3)	0	.160
Pharmacotherapy consult	0.08 $\pm$ 0.41 (1)	0.02 $\pm$ 0.09 (1)	.976
Miscellaneous			
Personal time	0.78 $\pm$ 1.17 (14)	0.84 $\pm$ 1.54 (12)	.544
Colleague/staff for nonpatient	0.15 $\pm$ 0.34 (10)	0.75 $\pm$ 1.28 (24)	0.118
Internet	0	0	N/A ^b
Other, miscellaneous	0	0.04 $\pm$ 0.14 (2)	.178

Note: CPOE = computerized provider order entry; eMAR = electronic medication administration record; IT = information technology; IV = intravenous.

^a*P* calculated using Wilcoxon rank-sum test. *P* < .05 is considered statistically significant.

^b*P* is not available due to no observations in CPOE and non-CPOE settings.

productivity numbers in pharmacy-wide order actions were exceeded.

Comparisons in the distributive activity were significant; 80% of the time was spent in the distributive activity for the non-CPOE site and only 72% was spent in the CPOE site. This is a mean of almost 5 minutes gained per hour from the non-CPOE pharmacy. This time could have been spent partly on clinical activities.

In terms of time, efficiencies were realized in the CPOE interventional group. The amount of time taken for tasks associated with order entry and order verification (the primary tasks of these pharmacists) combined was significantly reduced. A mean of over 8 minutes per hour was saved at the CPOE site. This is a 29% savings in time spent performing these 2 tasks.

The CPOE group spent a greater amount of time (almost 3 minutes per hour observed) in the administrative activity. The largest amount of this time was used in question and answer tasks with pharmacy management or in conversations with pharmacy management regarding pharmacy operations (4.21 minutes per hour). The time and motion instrument captured 6 instances of the CPOE pharmacists engaged in the administrative task shift reports, whereas none were noted in the non-CPOE group. If these reports resulted in a switch from intravenous to oral conversions of medications, the results could yield cost savings for the CPOE group.¹¹ It is also possible that administrative time may have been built into the pharmacists' schedule for purposes unknown to the observer.

There was a significant difference in the mean time spent by order entry pharmacists in the clinical activity. Approximately 3 more minutes were spent for each observed hour in the CPOE pharmacy. The majority of this time was spent by the CPOE group viewing the patients' eMAR and reviewing labs. This suggests a more thorough work-up of patients prior to order submission by the interventional group. It should be noted that even though 3 minutes per hour is statistically significant, this amount of time could be attributed to individual pharmacist workflow efficiency, among other factors.

The additional 5% of time spent by pharmacists in the clinical activity for the CPOE group translates to 2 hours gained per week per pharmacist. This would result in an additional 104 hours over a year per pharmacist, assuming all other variables remain constant. This corresponds with the 2003 American Society of Health-System Pharmacists (ASHP) roundtable discussion in which it was hoped that pharma-

cists would spend increased time optimizing and validating therapeutic regimens as a result of CPOE.⁸

The frequency of clinical interventions (7 vs 2) and eMAR/lab reviews (58 vs 24) was much greater for the CPOE than the non-CPOE site. Not only was the time spent in clinical activity increased in the CPOE site, but the productivity measures were also greatly increased.

These findings correspond to current research that notes a reduction in pharmacy turnaround time (TAT) as a result of CPOE. In one such study, TAT was defined as "the interval between the time the order was written [or entered into CPOE] and the time it [the order] was verified by pharmacy/automated dispensing device release."^{12(p133)} The study showed an 83.4 percentage point decrease in TAT, from 44.0 minutes to 7.3 minutes post CPOE deployment. It was reasoned at the conclusion of the study that the results could lead to enhanced communication between providers. This may support the decrease in number of medication requests and order clarifications by nurses that was observed in the CPOE group during our research. This would hold true particularly in hospitals utilizing automated dispensing cabinets, where medications potentially would be made available for administration at a faster rate as the result of efficiency gains in TAT after pharmacist verification post CPOE implementation.

Pharmacist productivity was decidedly greater for the CPOE versus the non-CPOE site. Greater numbers of order actions (71% increase) and order entry/verifications (39% increase) were processed per hour by the CPOE pharmacy. This increase in productivity was substantiated by a recent study conducted at a tertiary care hospital regarding the effect of CPOE on the increased efficiency of medication order processing time.¹³ The study was performed at Pitt County Memorial Hospital in Greenville, North Carolina. Pharmacy order processing time was defined in this study as the time from when the order was scanned (non-CPOE) or transmitted (CPOE) to pharmacist completion. This time was reduced by approximately 28 minutes post CPOE implementation.¹³

Even with the need for increased manipulation of the physician order as reflected in the increased order actions, the CPOE group did not suffer any loss in its ability to process administration ready orders, as seen by the increase in the mean number of order entry/verifications. Although our study did not examine order processing time as previously described by the Pitt Memorial study, it is not unreasonable to assume that the same trend would hold true for this CPOE study group.

The CPOE group received orders from their hospital emergency department. Pre-implementation, these orders were not sent to the pharmacy for prospective review, but the implementation of CPOE has made timely verification possible. The extent to which this increased the CPOE groups' productivity numbers was not fully known during the observation period of our research.

Our study supports current literature showing gains in productivity as a result of CPOE. It also provides insight into the types of gains that can accompany the successful implementation of CPOE by health system pharmacists. The extra time gained could be used to strengthen clinical services through therapeutic regimen monitoring or with physician rounding. In a presentation on changes in pharmacy practice after 10 years of CPOE, Vanderbilt Medical Center noted a change in pharmacy interventions toward comprehensive management of the patient with less time spent on data collection and entry; all professionals at the medical center shared the same database.¹⁴ Pharmacy leadership will have to plan ahead and be mindful of where efficiencies are gained post CPOE implementation.

Pharmacy leadership must also be aware of the strain that increases in productivity can place on the workforce. Recent literature has warned of a shift in workload as an unintended consequence of CPOE.¹⁵ As CPOE brings in prospective review of medication orders that originate from parts of the health system that were previously out of the scope of pharmacy order entry, such as the emergency department in our CPOE study hospital, careful consideration must be given to the benefit of pharmacists on patient safety and improved patient care. Pharmacy leadership must confirm that the improved efficiencies can sufficiently cover the additional tasks to improve patient safety and patient care.

In a recent survey of community hospital pharmacists, 79.1% of respondents did not include clinical activities and services in productivity monitoring even though 86.2% thought they should.¹⁰ As CPOE programs develop and efficiency gains increase, the practice of monitoring pharmacy services by way of full-time equivalent per doses dispensed or adjusted patient days, which are common workload measures within health system pharmacy, will fail to capture increases in clinical activity.

To optimize the benefits CPOE can have on pharmacy productivity, health system pharmacists must rethink how pharmacy services are viewed by hospital leadership and by their staff. Linking CPOE

efficiency gains to patient outcomes measures, length of stay, and cost avoidance is warranted. Expanded research is needed to underpin these claims.

Time and motion studies, although time consuming, provide valuable insight into how time is actually spent within the work environment. More studies, preferably ones using same-site CPOE implementation, are needed to further substantiate the time shift captured by our study. A survey of hospital administrators on their beliefs and perception of the impact of CPOE on pharmacy may provide insight about the direction and challenges that lie ahead for pharmacy leadership.

This study should be viewed in the light of several limitations. The 2 pharmacies were different in the number of pharmacists with PharmD degrees and amount of institutional experience. However, these variables could be offset to a certain extent in that the CPOE pharmacy had more PharmD pharmacists observed and the non-CPOE pharmacy had more institutional experience. The extent of possible offsetting could not be quantified in this study. Our study used a time and motion instrument that was reconfigured by our researchers to capture specific data needed for our hypothesis testing. To that extent, the instrument was new and, although tested at length before deployment, deserves additional field use to substantiate our findings. The acuity of the patient population was not measured, but it could impact productivity and observed time spent. The Hawthorne effect may be minimized by lengthier study sampling. The pharmacists who chose to take part in the study were informed of the purpose of the study, which could have led to bias. Our choice of aligning our observation period around the morning shift may not reflect the productivity of the evening or night order entry team, where shifts in time spent on the 4 major activities tested could potentially occur. The number of orders dispensed through the automated dispensing cabinets and the number of oral and intravenous orders were not available to be reported. The number of order actions and order entry/verifications were collected on a pharmacy-wide basis. Although the mean number of pharmacists at both the CPOE and non-CPOE pharmacies was the same, these figures cannot translate directly to the productivity of each pharmacist observed due to the variability of productivity between pharmacists; this analysis was conducted on the pharmacy level, not the individual level. Follow-up studies may be employed specifically to evaluate data for these variables.

CONCLUSION

Pharmacy productivity was positively impacted by CPOE. Pharmacists spent more time performing administrative and clinical functions and less time on distributive responsibilities. With subsequent gains in efficiency of orders processed, hospital pharmacy leadership must plan prudently to demonstrate the value of increased pharmacy services in other activities, such as clinical and administrative.

REFERENCES

1. Bates DW, Leape LL, Cullen DJ, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA*. 1998;280:1311–1316.
2. Bates DW, Teich JM, Lee J, et al. The impact of computerized physician order entry on medication error prevention. *J Am Med Inform Assoc*. 1999;6:313–321.
3. Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: A systematic review. *Arch Intern Med*. 2003;163:1409–1416.
4. Kohn LT, Corrigan JM, Donaldson MS, eds. *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press; 1999.
5. The American Recovery and Reinvestment Act of 2009. H.R. 1. <http://thomas.loc.gov/cgi-bin/bdquery/z?d111:h.r.00001>. Accessed October 15, 2012.
6. Centers for Medicare & Medicaid Services. EHR incentive programs. <http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/>. Accessed July 9, 2012.
7. Healthcare Information and Management Systems Society Analytics Database. United States EMR Adoption Model. <http://www.himssanalytics.org/home/index.aspx>. Accessed March 4, 2014.
8. CPOE, bedside technology, and patient safety: A roundtable discussion. *Am J Health Syst Pharm*. 2003;60:1219–1228.
9. Agency for Healthcare Research and Quality. Time and motion database. <http://www.innovations.ahrq.gov/content.aspx?id=2489>. Accessed July 9, 2012.
10. Gupta SR, Wojtynek JE, Walton SM, et al. Monitoring of pharmacy staffing, workload, and productivity in community hospitals. *Am J Health Syst Pharm*. 2006;63:1728–1734.
11. Steele AM, Debrow M. Efficiency gains with computerized provider order entry. In: Henriksen K, Battles JB, Keyes MA, et al, eds. *Advances in Patient Safety: New Directions and Alternative Approaches – Volume 4: Technology and Medication Safety* [AHRQ publication no. 08-0034-4]. Rockville, MD: Agency for Healthcare Research and Quality; 2008.
12. Dunn K, O'Reilly A, Silke B, et al. Implementing a pharmacist-led sequential antimicrobial therapy strategy: A controlled before-and-after study. *Int J Clin Pharm*. 2011;33:208–214.
13. Wietholter J, Sitterson S, Allison S. Effects of computerized prescriber order entry on pharmacy order-processing time. *Am J Health Syst Pharm*. 2009;66:1394–1398.
14. Huffines SK. A view from the other side: Changes in pharmacy practice after a decade of an integrated computerized provider order entry (CPOE) System (TECH-2). Paper presented at: ASHP Midyear Clinical Meeting; December 4, 2006; Anaheim, CA.
15. Ash JS, Sittig DF, Dykstra R, et al. The unintended consequences of computerized provider order entry: Findings from a mixed methods exploration. *Int J Med Inform*. 2009;78(Suppl 1):S69–76. ■