Computerized practitioner order entry (CPOE) is a major initiative for many healthcare organizations across the country. With the publication of “To Err is Human,” organizations have begun the initial process of addressing and planning for implementation of information technology systems to help minimize the risk of errors, reduce costs and improve patient care. Nurses have long been identified as a central component to the delivery of healthcare, so their involvement is critical for a successful implementation of any information system, and they are directly affected by any change such as CPOE.

The current process of using handwritten orders, while
fraught with potential errors in transcribing and interpretation, remains a very efficient process for directing inpatient care. Many of the nearly 10 percent of American hospitals that have implemented CPOE report that it is not a panacea for preventing errors.

Studies have shown that there are obvious changes with CPOE, such as electronic data entry, and more subtle changes, such as the communication process between physicians and nurses. In a University of Pennsylvania study, the use of CPOE resulted in decreased collaboration between nurses and providers. As physicians entered orders, a printout, which did not always have clear content, was produced for the nursing staff. By not seeing the physician writing the order, the nurse was unable to converse with the provider about the order and obtain clarification, if needed.

Mayo Clinic Arizona (MCA), an acute-care facility with more than 200 beds, is concerned about the impact CPOE has on communication between physicians and nurses. Having successfully used the team approach in previous information system implementations, the facility began CPOE implementation by creating teams to assess and plan for the impact that CPOE would have on the entire medical team. MCA nurses began by researching literature, making site visits to facilities already using CPOE and interviewing peers.

Early in the assessment process, the nursing team identified that the No. 1 concern of the nursing staff was timely notification of new or changed orders. This article covers the process the nursing team used to evaluate the issues of timely order notification and provider-nurse communication. The discussion will include a list of possible solutions and which solutions were chosen by MCA.

**Workflow Change Areas Identified**

The nursing CPOE team’s work began in February 2005 with a kickoff meeting. Team members determined that critical components of a successful solution included maintaining or enhancing the amount of information available, minimizing input time and neutralizing the impact on all care providers. A timeline for CPOE implementation was established for the second quarter of 2005, with a pre-pilot rollout to a seven-bed inpatient rehabilitation unit, then a pilot implementation on a 36-bed surgical orthopedic unit.

Members on the nursing team included IT analysts, a unit secretary and nurse managers from rehabilitation and orthopedic nursing units, unit-based educator staff, the IT project manager, clinical education staff, and nursing informatics staff. The nursing informatics manager led the team in setting agendas, creating an issue list for follow-up items, assigning tasks, and documenting the discussion in meeting minutes.

Early in the process, a key addition to the group was an IT nursing informatics CPOE consultant who had previous experience with CPOE implementations at two other healthcare organizations. The consultant aided in the development of a streamlined workflow and end-user interface by identifying and analyzing issues specific to the organization. Drawing on past experience and knowledge of the software applications, the consultant also identified solutions to maximize performance of the chosen systems and encourage the development of new technologies.

As the team began its work, it became apparent that significant workflow changes would need to occur with CPOE, particularly in the nursing units. Several primary workflow issues were identified. For example, the unit secretary staff, which currently performs non-medication order entry, would see a change in their role. In the non-CPOE environment, the nursing staff relies heavily on the unit secretary to keep them informed of order changes, particularly those that require immediate or stat interventions by a nurse. The team recognized that this role would still be an important part of the process, based on how they could use secretaries’ skills in a CPOE environment.

The team also recognized that there would be a loss of visual clues about orders. In a non-CPOE environment, the physical presence of the provider on the nursing unit alerts the nurse that an order may be forthcoming. However, in a CPOE environment, physicians will be placing inpatient orders from multiple locations, both on and off the nursing unit. This lack of visual clues and decreased presence on the unit also can lead to reduced communication or fewer interactions between the nurse and physician.

Finally, chart tabs no longer can communicate to the nurse the presence of new orders. In a non-CPOE environment, handwritten orders are placed in a patient’s chart and the provider indicates new orders by raising a tab and placing the chart in a specified location. If there are specific orders that need to be initiated quickly, a stat order flag also is raised to alert staff to its urgency. In a CPOE environment, the physical chart and its location no longer would serve as a visual clue when a provider writes a new order.

**Options to Address Nursing Issues**

The nursing CPOE team viewed the loss of visual clues about orders as a critical issue that could directly affect the delivery of care, and it agreed that an optimal solution for MCA needed to be identified. A key requirement of any solution was that it must not require any additional time commitment from nursing staff. To help identify the best options, the team interviewed a diverse sample of MCA staff, interviewed clinicians from other CPOE sites, and studied published literature on this issue.

This analysis yielded five potential options to address the issue of the loss of visual clues for orders. They included developing a Web-based nurse order notification application for viewing at nurses’ stations; generating a printed report when order changes occur; developing online order change alerts for nurses; providing pager notifications; or developing a nursing policy that encourages the active review of
The CPOE nursing group created an initial list of pros and cons associated with each solution (see Figure 1). Next, the IT project manager and nursing informatics manager conducted an in-depth analysis of each option, including the costs associated for each option.

Based on an initial analysis, the nursing CPOE team dismissed the following three of the potential options as not viable for MCA.

<table>
<thead>
<tr>
<th>OPTION</th>
<th>DESCRIPTION</th>
<th>PROs</th>
<th>CONs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Develop Web-based Application for Viewing at Nurses Station (Nurse Order Notification Application)</td>
<td>• Can differentiate between STAT and Routine orders&lt;br&gt;• Non-invasive option for nursing staff, only visual queue required&lt;br&gt;• Similar to current system of tabs on paper charts</td>
<td>• New development effort required&lt;br&gt;• On-going support likely&lt;br&gt;• Additional hardware in form of PC’s required&lt;br&gt;• Would take time to develop</td>
</tr>
<tr>
<td>2</td>
<td>Generate a Printed Report as Order Changes Occur</td>
<td>• Easier set-up&lt;br&gt;• Staff are accustomed to dealing with paper HIS reports in the form of the PMP and the Kardex</td>
<td>• Considerable amounts of wasted paper and toner&lt;br&gt;• Lost pages and/or reports could lead to confusion&lt;br&gt;• Requires effort from nursing to gather reports and unit secretaries to collate reports</td>
</tr>
<tr>
<td>3</td>
<td>Develop Online Order Change Alerts for Nurses (in HIS)</td>
<td>• Option would be patient and user specific&lt;br&gt;• Would provide an easy visualization queue when compared to online review (option #5 below).</td>
<td>• Little HIS rules-based knowledge currently in-house&lt;br&gt;• Ongoing maintenance would be required for rules developed&lt;br&gt;• Resource intensive to look up as staff would need to log in HIS to determine if new orders flag was valued for their patients&lt;br&gt;• No differentiation of STAT versus Routine orders</td>
</tr>
<tr>
<td>4</td>
<td>Pager Notification</td>
<td>• Instant notification process&lt;br&gt;• Little effort required by staff to obtain updates</td>
<td>• Technology to generate pages or phone alerts would need to be sized and developed&lt;br&gt;• Could be disruptive to staff&lt;br&gt;• Unsure how phone messages would work if staff on a call and no voice mail capabilities exist&lt;br&gt;• Not all staff have pagers; would require purchase of pagers if these were used&lt;br&gt;• No differentiation of STAT versus Routine orders</td>
</tr>
<tr>
<td>5</td>
<td>Develop a Nursing Policy that Encourages the Active Review of Online Orders</td>
<td>• Little additional cost in resources; possibly some cost in additional device purchases&lt;br&gt;• Little additional effort to implement other than training</td>
<td>• Staff does not have time to constantly log into HIS to check status&lt;br&gt;• Additional PC’s would likely be needed to support increased usage requirements&lt;br&gt;• Would require time to check all patients to see if new orders were written</td>
</tr>
</tbody>
</table>

online orders.

Generating a printed report as order changes occur. The periodic generation of a printed report with an updated list of new orders is a common approach among institutions using CPOE. However, the team believed that this option was less than optimal for several reasons. First, the sheer volume of printed paper from CPOE can overwhelm nurses and cause them to be more focused on task completion than on the big patient-care picture. Second, paper reports can become outdated very quickly as new orders are entered into the system. In addition, there is a significant chance that the pages of printed reports will get lost or mixed up, leading to incomplete data or misinformation for the person reviewing them. Finally, reports generated frequently enough to meet the needs of the nursing staff would ultimately mean significant costs in paper and toner.

Paging notification. While communication devices, such as pagers, now are widely available, pagers in an automated process have been mainly used for alerting staff about resulted values. To achieve this option, MCA would have to implement a paging system that would send nursing staff a text message each time new orders were generated by physicians. While more desirable than printed reports, nurse paging was viewed as a less-than-ideal solution. The pagers could be a disruption to staff and patients, would not differentiate a stat vs. a routine priority order, and would require equipping the nursing staff with pagers, which few of them use today.

Nursing policy encouraging the active review of online orders. The team determined that it would be
ineffective to develop a nursing policy to direct staff to log into the ordering system and review the orders profile at specific intervals, for example every hour, to assess the current order profile status. Additionally, it was felt that the increased level of system activity associated with this checking would increase the demand for computer time, which was expected to be a valuable resource as the need for available computers will rise as physician ordering increases with the rollout of CPOE.

As a result, the nursing CPOE team recommended the two remaining options—developing a Web-based application for viewing at nurses’ stations (the nurse order notification application) and the development of an online order change alert for nurses. The team took their recommendation to the steering committee for review and approval for funding, and that panel endorsed the two recommended options.

Rationale for the Approaches

The development of a Web-based application for order notification was selected because it was the solution that best mirrored the current communication process between the physician and nurse. The current hospital information system was linked to a replicated database for report writing and data extraction; the database would be mapped to the Web-based application with refreshing functionality every few minutes as new orders are entered (see Figure 2).

Orders would be grouped into two categories to display, based on the routine or stat priority entered by the physicians. The application displays the nursing unit room number and has two columns beside each room, one for routine orders, which are highlighted in green, and one for stat orders, highlighted in red; these colors replicate the chart tab colors. Each nursing pod, which has approximately eight to 10 beds, will have a computer monitor for viewing the application. With just a quick glance at the dedicated monitor, nurses will be able to see how many routine or stat orders are awaiting their review. After becoming aware of new orders, nurses will log onto the HIS application and go to the individual patient's order profile, where new orders are highlighted for review. After reviewing each order, the nurse simply clicks on the nurse review function, signaling awareness of the order. This online review function then triggers the Web-based application to update the display for that room and incrementally reduces the number of unreviewed orders.

At each central nursing station unit, a larger monitor will display the same data for all 30 to 40 beds associated with that unit. The nursing team leader and unit secretary will observe this display for new orders, particularly those with stat priorities. This additional level of monitoring will help alert staff nurses to more urgent orders. As patients are discharged or transferred from the unit, the display will automatically be updated.

One prerequisite for this option to work is that all orders must have a priority indicated. With the current process, pharmacists enter all medication orders into the hospital information systems after receiving the written order from the nursing unit via fax. The pharmacist translates the specified urgency into the appropriate start date and time but does not enter a priority indicator. For a CPOE environment, MCA needed to create a priority field on the medication ordering screen for physicians to indicate urgency. This priority field then will determine the medication start date and time with the help of a rule-based program. This process and screen change is required for the Web-based application to display all orders in either the routine or STAT column.

The second solution approved by the steering committee was the development of an online alert for nurses as they log in. This alert will create a pop-up window to display all new or changed orders for assigned patients immediately after accessing the hospital information system, serving as a supplemental notification to nurses for new orders, but it does require accessing the application to initiate. Further analysis determined this functionality to be part of the standard product update for the HIS to be installed before the CPOE implementation. This update will provide a list of new or changed orders for assigned patients, and it will enable the nurse to click on the patient name and go directly to the order review process.

Aiding Physician-Nurse Communication

The CPOE nursing team also made an additional recommendation to the steering team dealing with the physician-nurse communication process and the awareness of patient-nurse assignments on any given shift. In the current environment, the physician communicates patient care orders to the nursing staff either by phone, as verbal orders, or in person, through written orders on the chart.

When a physician needs to speak to the nurse caring for a patient, it is not always known who the assigned nurse is at the beginning of each shift or how to reach them. Each nursing unit has a paper assignment sheet containing the
nurse-patient assignments for the shift along with contact numbers. This assignment form is faxed at the beginning of each shift to the lab, radiology, and pharmacy areas so they can directly contact the nurse assigned to an individual patient, if needed. However, the information on these assignment sheets becomes outdated shortly into a shift, as patients begin to move around and staff assignments change because of discharges, admissions, and transfer activity.

With the planned implementation of CPOE, there are concerns that the direct, verbal communication between the physician and nurse regarding patient care orders would be decreased. This may lead to less efficient and effective patient care. The CPOE nursing team recommended adapting the nursing assignment sheets to a Web-based application, which would be launched from the log-on toolbar and would be updated in real time. Access to these assignment sheets would be given to all clinical staff, including physician and physician extenders, so they could contact the nurse directly regarding care issues.

Patient information would be provided from a hospital information system feed and a designated person would manually enter the nurse assigned to the patient and their phone number for each unit. Sort and search capabilities would be built into the application to improve utilization of the information. An option would be provided to enable staff to print and post a copy of each nursing assignment sheet as needed. Data would be archived and available for retrieval by the nurse managers when needed. Audit trails would help track who made assignment changes, as well as who accessed data and when (see Figure 3).

The benefits to this application include:

- Improved communication between nurses and physicians by providing a more efficient method of identifying the nurse and a direct phone number where they can be reached.
- Search options to quickly locate a patient or identify the nurse assigned to the patient.
- Provide an up-to-date application for support staff to access and contact nurses directly.
- Electronic archiving for as much as three years of required information on patient assignments, thus reducing the need for storage of paper assignment forms.

IT sources needed for this application include staff from client workstations, data warehouse, applications, and the software architect.

**Current Implementation Status**

Early adoption of MCA’s Web-based applications and process changes is viewed as critical in transitioning to CPOE. With this in mind, the prototypes for both of the Web-based applications have been completed and testing has been initiated.

The Web-based application for viewing orders at nurses’ stations was implemented in November 2005 as part of MCA’s strategic plan to introduce CPOE process changes before going live. Hardware was installed on the rehab and orthopedic nursing units, both identified pilots for CPOE.

The medication priority field on the medication ordering screen to indicate urgency also was implemented in November 2005 for initial use by the pharmacist staff entering orders. Feedback from staff has been extremely valuable as we continue to evaluate this option. While nurses are not yet relying on this application for notification of new orders, they are becoming acclimated to its presence and how it will increase in value as the CPOE process is rolled out in 2006.

“The CPOE implementation process has to be an organization-wide initiative with everyone sharing the workload it creates.”

The functionality for the online order change alert for nurses was part of the standard product update for the HIS to be installed before CPOE implementation. The software was received by MCA in December 2005 and is currently being loaded for testing. In the first quarter of 2006, the software will be tested and tailored and is scheduled to be implemented in a production environment in March 2006.

The nursing assignment sheet online is in the final development stage and testing. As the prototype has been built, demonstrations have been given to the steering committee, the hospital-based leadership team, and the CPOE nursing group. The feedback from these groups has been extremely positive; in fact, it has been so successful that additional requests by physicians to add their on-call data now are being considered as a second phase for the project. The goal for this application is to complete the build, finalize testing, and implement it within two nursing units in early
2006. After evaluation is complete, this application will also be initiated pre-CPOE to help cushion the implementation process.

**Lessons Learned**

Although MCA has not fully implemented CPOE yet, organizationally it has learned several lessons from the process. While hospital information system vendors offer myriad solutions for CPOE, the healthcare institutions need to identify and address the functional gaps that can occur related to CPOE. Teams need to be formed to help divide the enormous work efforts into more bite-size pieces. The CPOE implementation process has to be an organization-wide initiative with everyone sharing the workload it creates. The use of innovative technology can help the healthcare organization actively push the process along, rather than passively pulling it along.

Early adoption of process changes, when possible, can help to generate positive outcomes for the CPOE project and minimize the go-live stress that is inevitable with a project of this magnitude. The early introduction of change helps to create a network of nurses, pharmacists and other support personnel that are proficient in the new workflow and able to serve as super users for the provider community when CPOE is implemented.

Additionally, introducing system and workflow changes before practitioner order entry enables the existing order entry experts to evaluate the impact of the change. The pilot of the nurse notification application identified several issues where end-users had modified current processes to accommodate system and workflow issues. These undocumented work-arounds had not been considered during the development of the application. Issues now can be addressed and resolved before beginning practitioner order entry.

**Conclusion**

The CPOE workgroups are continuing to work through the list of workflow changes and creating solutions for each process change. Each team is learning about the many unknown order processes that occur outside their own departments. Automation of a manual handwritten process such as CPOE creates a domino effect on all order receiving departments. Human interactions and communication processes, which are both key elements to a successful order-entry process, need to be reassessed as part of the CPOE review process.

The introduction of a CPOE system not only introduces organizational changes but also has a strong impact on physicians and nurses. The communication process is indeed complex and can be negatively impacted by a CPOE implementation. Communication strategies need to be evaluated with a CPOE implementation and creative solutions developed to help channel new links. The implementation is crucial as healthcare organizations strive to provide a safe environment for patient care. With that come process changes that need to be identified and alternative solutions researched to ensure success. The innovative use of technology for order visualization and physician-nursing communication are just two methods to employ for a smooth deployment of CPOE.

**About the Authors**

Mary J. Wright, RN, MN, BC, is the manager of nursing informatics at Mayo Clinic Arizona. She is responsible for the management of nursing clinical applications and new technology planning.

Keith Frey, MD, MBA, is a physician and CMIO at Mayo Clinic Arizona and associate professor of family medicine at Mayo Clinic College of Medicine. He chairs the IT steering committee.

Jeffery Scherer, MBA, is an IT customer relationship manager at Mayo Clinic Arizona. He is the project lead for the CPOE implementation and coordinates all IT aspects of the project.

Debra Hilton, RN, is a senior information system consultant at Coastal Healthcare Consulting. She has expertise in guiding multiple CPOE implementations at large private teaching organizations.

**References**