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IN THIS ISSUE

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Electronic prescribing can improve medication safety

Clinical decision-support capabilities key

A University of Washington study has found that potential prescribing errors frequently occur but don't generally reach the patient or cause harm. The researchers say the most severe errors may be reduced by implementing an electronic prescribing system with clinical decision-support capabilities.

According to lead study author **Emily Beth Devine**, PharmD, MBA, BCPS, FASHP, in the University of Washington's Department of Pharmacy Pharmaceutical Outcomes Research and Policy Program, four Institute of Medicine reports have established patient safety as a national priority for research, identified patient safety as one of six U.S. health care system dimensions needing improvement, described how an information technology infrastructure is central to the needed improvement, and begun to outline a comprehensive plan for implementing and standardizing the infrastructure to support health care delivery and improve patient safety.

Electronic prescribing with clinical decision-support capabilities has emerged as a part of the infrastructure and as a viable option for improving patient safety by decreasing medication errors, Devine says.

The research, reported in the *American Journal of Health-System Pharmacy*, was conducted at The Everett Clinic, which is owned and managed by 250 physicians who provide primary and specialty care delivered in 60 clinics in 13 geographic locations in the state of Washington. The care delivery system includes two ambulatory care surgery centers, a cancer center, comprehensive laboratory and imaging services, three community pharmacies, and a hospitalist team that admits to the local community hospital. The clinic's physicians write more than 2.5 million prescriptions a year. Everett Clinic contracts with 18 separate health plans, each of which has its own drug formulary.

Devine tells *Drug Formulary Review* that the clinic was interested in building an electronic prescribing system to add to its electronic medical record in hopes that it would improve medication safety. They started brainstorming electronic prescribing systems in 2002 and

implemented their project in July of 2003, she says.

The research study called for a retrospective review of prescriptions written in one internal medicine clinic, which was the first entity to receive the electronic prescribing system, within the larger health system. Prescriptions were written between March 1 and July 15, 2002, 12 months before implementation of the electronic prescribing system and well before the prescribers knew of the study.

Three data sources

The three data sources reviewed were the handwritten prescription, the electronic medical record, and the prescription as it was entered into the pharmacy computer system. The study scope was limited to evaluating prescriptions for medication errors and potential errors that could be attributed to having occurred during the prescribing process.

Reviewing each prescription as it was entered into the pharmacy computer system enabled assessment of errors and potential errors arising from discrepancies between each prescription as written and each prescription as entered into the pharmacy computer system. With that information, prescription legibility from the perspective of the pharmacist was assessed. Errors attributed to the prescribing process and errors attributed to the order-entry process were determined by reviewing notes made by the pharmacist on each prescription. (Pharmacists make clarifying notes on prescriptions after discussion with a prescriber.)

In the absence of notes, if a researcher identified a discrepancy between a prescription as written and the prescription as entered into the pharmacy system, the discrepancy was attributed to a prescribing error such as illegibility. The presence of notes indicated to the researcher that the pharmacist had clarified the prescription with the prescriber and thus any discrepancy between the prescription as written and as entered into the pharmacy system was attributed to order-entry error. Capturing order-entry errors was outside the study scope.

Three clinically trained pharmacists evaluated the data—one was a primary care specialist, the second was in geriatric pharmacotherapy, and the third was in general clinical practice. By using the electronic medical record as one of the data sources, the researchers said they were able to evaluate each prescription and error in the clinical context, taking into consideration patient comorbidities and concomitant medications.

Medication errors were found in 386 (27.4%) of the 1,411 prescriptions evaluated. Some 77 prescriptions contained more than one error, bringing the total to 463, or an error rate of 32.8%.

Evaluate nine severity levels

The study used a scale with nine levels of severity ranging from level A (circumstances or events that have the capacity to cause error) to level I (error occurred, reached patient, contributed to or resulted in death). By far, Devine says, the largest proportion of errors was attributed to those in severity level A. No errors were categorized as level B. Thirty-two errors (6.9%) reached the patient and had the potential to cause harm (levels C through I). Only one error caused patient harm (level E—"error occurred, reached patient, may

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have contributed to or resulted in temporary harm, required intervention") and no errors were categorized at levels more severe than level E.

The characteristic most frequently identified was missing information, but only three of those 122 errors reached the patient and none caused harm. Incorrect directions and illegible prescriptions also occurred with a frequency of greater than 10%, but caused no harm. Several administrative errors were documented, all involving the number of prescription refills authorized and all were level A.

Some 21% (97 of the 463) of errors were characterized as clinical errors. The most frequently characterized clinical error was a contraindication of a drug for a patient at least 65 years old. Of the clinical errors, the more severe errors were most often characterized as drug-disease interactions, with three at level D and one at level E, followed by a lack of appropriate laboratory monitoring (two level D).

The researchers reported that more than 90% of the errors identified were not actual errors but rather potential errors. While 6.9% of the errors reached patients, meaning they had the potential to cause harm, only 0.2% actually did cause harm, an error rate of two in every 1,000 prescriptions written.

Devine tells *DFR* the findings were consistent with other studies that have shown that relatively few errors actually lead to patient problems. While the researchers had suspected that the error characteristics most likely to occur would be illegibility and allergy and drug-drug interactions, illegibility actually ranked third in the list of non-clinical characteristics that caused an error, behind missing information and wrong directions. Errors involving the Beers criteria (used to determine appropriateness of prescriptions for those at least 65 years old), drug-disease interactions, and lack of appropriate laboratory monitoring occurred more frequently than did errors involving allergies and drug-drug interactions.

Of the errors that had the potential to cause harm, only one of the non-clinical characteristics required monitoring to prevent harm (level D)—a dose that was too high. The characteristics of errors that required monitoring to prevent harm (level D) and the characteristic of the one error that caused harm (level E) were clinical errors.

E-prescribing can help non-clinical errors

The researchers said they believe that it is the non-clinical errors that may be affected by a basic electronic prescribing system (illegibility, missing information, wrong dose), while those defined as clinical errors may be affected only when more sophisticated levels of clinical decision-support programming are added. Devine said the Everett Clinic has used the study results to prioritize development of clinical decision-support programming that will provide prescriber alerts for drug-disease interactions and guidelines for appropriate laboratory monitoring to prevent harm.

An electronic prescribing system with clinical decision support, she says, will provide patient-specific or drug-specific information to prescribers at the point of care. She says such systems are most useful when they actively present information to prescribers as they go through the prescription ordering process, rather than passively waiting to be asked for information. ■

[Editor's note: Contact Dr. Devine at (206) 221-5760 or e-mail bdevine@u.washington.edu.]

Reference

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Medication errors cut by bar-coding and observation

Methodology lends itself to measurement

A 54% reduction in medication administration errors was recorded at Pennsylvania's Lancaster General Hospital as a result of direct-observation methodology used to monitor medication administration before and after deployment of electronic medication administration records and bar-coded medication administration.

In a research study reported in the *American Journal of Health-System Pharmacy*, **Richard Paoletti,** MBA, BSPharm, and colleagues say the goals for a multidisciplinary approach to systematically decrease medication errors through use of observation methodology and deployment of electronic medication administration records (EMAR) and bar-coded medication administration (BCMA) included: 1) effectively using an observation-based medication error detection system to provide a

reliable and effective mechanism for identifying medication errors during administration; 2) identifying and implementing a best-practice technology solution for EMAR and BCMA verification; 3) improving pharmacy and nursing communication; 4) maintaining nursing satisfaction through minimizing additional workload; 5) projecting a patient safety leadership role to the community; and 6) establishing a data source to allow for continual and effective identification of systems issues to facilitate a proactive approach to prevent medication error occurrence.

Joining Lancaster General Hospital's multidisciplinary team for this project were representatives from the administrative, medical, nursing, pharmacy, information services, security, marketing, registration, and staff development departments. The team was formed to improve the safety of the medication administration process through a reduction in medication errors.

Direct observation facilitates measurement

The team decided to use a direct observation process to get an accurate measurement of current error rates, system enhancements, and goal achievements because that method allows hospitals to identify faulty processes, recommend system changes, and evaluate changes with consistent and reliable data. The observation technique was used in addition to the hospital's self-reporting system rather than in place of it.

Four nurses were trained in a nationally recognized certification program for the observation process. These four certified medical observers observed nurses throughout the entire medication administration process during peak workload periods in selected nursing units. Bedside observations were recorded and later compared with patients' charts to identify discrepancies between observed medication administration and physician orders.

Three inpatient nursing units participated in the study—intervention group 1 was a 20-bed cardiac telemetry unit and intervention group 2 was a 36-bed medical-surgical unit, while a 20-bed cardiac telemetry unit was the control group and was included to monitor for other variables that may affect the medication administration process.

During the study's first phase, the three units participated in evaluating the medication administration process with a five-day medication administration record. The observers noted that intervention group 1 had a lower variation in medication orders because of the aggregated cardiac patients and use of standardized order sets. That group had also implemented a double-check process using two nurses to verify transcription of all medication orders. Because of those variances, the observers believed the medication administration process for intervention group 2 was a more valid comparator with the control group.

The observers found 188 total errors. The vast majority were classified as wrong time (143) and were typically late doses. Others types of errors noted included omission (15), wrong technique (14), wrong dose (6), extra dose (5), wrong medication (3), wrong route (1), and wrong formulation (1).

Opportunity for significant improvement

Extrapolating those findings to the hospital's 521 licensed beds, which are at more than 90% capacity, the team saw an opportunity to make a significant improvement. They quickly identified the hospital's handwritten, non-pharmacy-generated, five-day medication administration record as a problem area. They also found that the administration phase of the medication-use process was particularly vulnerable since safety nets relied on nurses to remember, identify, and resolve discrepancies at the bedside. A decision was made to implement a pharmacy-driven EMAR and BCMA system.

Issues addressed before implementation of the new system included:

Infrastructure. A wireless network was necessary for nurse workflow and future clinical information system needs.

Device and stand selection. Staff nurses were asked to participate in selecting the devices and stands, including the quality and availability of equipment. A mobile computing tablet with a bar-code scanner was selected, with consideration for nurse workflow related to medication administration and future clinical documentation needs. One device per staff nurse was bought, along with an additional device per nursing unit.

Pharmacy. Pharmacist order-entry activities lacked much of the clinical parameters included in physician orders. Considering the move to a pharmacy-driven EMAR, an extensive amount of work occurred in the pharmacy relating to completeness of order entry. Staff performed several system enhancements to the clinical information system to comply with EMAR specifications. Also, action orders were created in the pharmacy system to prompt nurses with clinical notes and

monitoring parameters for specific medications. A paper, fax-based nursing-pharmacy tool was developed to enhance communication of order-entry issues. Barcoded packaging systems were investigated and used.

Different labeling formats and packaging techniques were piloted, with a focus on quality to provide nurse end-users with accurate and functional bar codes. Pharmacy labels were reformatted to accommodate the bar codes. Staff say they gave careful consideration to bar-code content, and most bar-codes were derived from the product National Drug Code. Codes for some specialized products such as pediatric preparations and compounded solutions were based on the order number generated by the pharmacy information system.

Medication administration guidelines. All workflow issues involved in the medication-use process were identified through nurse-pharmacist collaboration. Modifications made because of the effect of EMAR and BCMA included nursing-pharmacy communication, real-time reconciliation of medications ordered, administration of medications, and documentation strategies.

Communication. A plan was established to communicate this patient safety initiative to employees, physicians, patients, families, and community members. The team created a patient handout to explain the intention to provide patients with a safer medication administration environment.

Employee identification. A process was established to change the employee identification badges to accommodate a bar code for access to the BCMA system.

Patient identification. Paoletti says the first step in "five-rights" verification is patient identification. To ensure patients are identified correctly, the team determined that all patients needed to have bar codes on their wristbands. That necessitated a new system implementation and consideration of the specific needs of the BCMA system including quality, durability, and security of the wristbands. The team mandated that the wristbands could only be obtained through the admissions office to protect system integrity. Nurses were not granted access or permitted to reproduce the wristbands as part of the plan to minimize unsafe work-arounds. Ongoing integrity of the BCMA system for patient safety continues to be a priority in projects that use barcode technology. Thus, when bar-coded chart labels were introduced to replace an existing patient demographic stamp system, the chart label was created without the ability to be scanned to ensure use of the patient wristband in the BCMA system.

User education and support planning. The hospital recognized that implementing EMAR and BCMA presented nurses with a significant practice change in terms of the medication administration process. A four-hour class and additional computer-based learning modules were provided for all nursing personnel. Nurses also observed the process on units using EMAR and BCMA before their implementation. Support was provided on each nursing unit 24 hours a day for the first seven days of "go live" implementation. Also, pharmacists and physicians were encouraged to participate in the training program to gain an understanding and appreciation of the effect the innovative system would have on nursing.

Downtime process. A contingency plan was created and established to cope with scheduled or unplanned downtime.

Additional personnel. Paoletti says appointment of a dedicated clinical nurse as system administrator was a significant key to the initiative's success. Responsibilities for this position included oversight and daily system monitoring, data analysis and integrity, and establishing useful reporting. Nurses typically reported a slight increase in time needed to support medication administration because of the scanning process, but this factor has not been scientifically measured. The need to repackage and bar code a substantial amount of medication resulted in addition of one pharmacy technician dedicated to that task. And the team says an additional pharmacist for checking, validating, and managing the repackaging effort would be a valid consideration.

The new EMAR and BCMA systems were implemented on one nursing unit beginning August 2003 and spread to all patient units by July 2004. The team originally wanted to have hospital-wide implementation completed by December 2003 but the date was pushed back to accommodate training demands.

Competing systems make transfers difficult

During the implementation period, internal patient transfers became difficult because of the difference in systems on various nursing units. The planned implementation scheme was revised to deploy "feeder" units in sequence. An additional obstacle that was uncovered was the unavailability of hallway electrical outlets because of the hospital's age. The facilities department had to add addi-

tional power sources to many of the nursing units and extended-life batteries were obtained to support the new equipment.

In the study's second phase, the control group continued to use the five-day MAR without changing the process, while the two intervention groups were measured to evaluate the medication administration process using EMAR and BCMA technology. The intervention groups were monitored to allow for total visibility to different practices affecting the medication delivery process.

Paoletti reports that post-implementation data for intervention group 2 demonstrated a 54% reduction in medication errors. While the same reduction was not noted in intervention group 1, the observers identified differences in practices during the study's baseline phase in comparison with the control group.

Now in all impatient units and other areas

Today, the EMAR and BMCA program is deployed in all inpatient nursing units and in additional care areas including the medical outpatient unit, outpatient infusion center, cardiac catheterization laboratory, and post-anesthesia care unit. Paoletti says implementation of the new system "has provided significant enhancements to medication administration. In addition to the noted reductions in medication error rates, this program has enhanced our ability to capture valuable data related to medication administration and compliance with established medication administration processes."

One of the most important aspects of this medication safety initiative is the ongoing systematic, direct observation of medication administration on nursing units, Paoletti says. During unannounced, regularly scheduled observation, the certified observers continue to monitor the entire medication delivery process, allowing for early identification of non-compliance to established procedures. He says the technique also provides accurate information to decision-makers who are better equipped to make procedural changes to continually enhance medication-use system safety.

The direct observation accuracy rate before BCMA was 86.5%. After implementation of the bar-code system, the accuracy rate rose to 97%. Paoletti says the system has led to a 54% decrease in the medication administration error rate. ■

Human factors engineering to improve technology

Improve safety while cutting costs and time

Implementing technology that considers human factors engineering in inpatient pharmacy operations processes of medication ordering, preparation, and dispensing can help pharmacies become safe and reliable while cutting costs and reducing turnaround times. That's the conclusion of Cleveland Clinic pharmacy informatics specialist **Scott Kulper**, PharmD, and colleagues in a commentary published in the *American Journal of Health-System Pharmacy*.

Kulper says the error-prone inpatient pharmacy component of the medication-use process relies on interactions among providers, patients, information, and technology, and the majority of medication errors are a direct result of the intrinsic complexity of those interactions. While successful technologies can reduce the potential for human error by automating tasks requiring high levels of accuracy and repetition, he says, diligence must be taken as automating a faulty process will fail to address problems and will provide new error sources.

"The ability to reason and learn from past experiences allows us to develop robust systems that support human work," he says. "It is important to understand human limitations and abilities when designing a system or when trying to understand why errors are occurring within a system."

Normal accident theory, he says, characterizes complex systems and explains why they are prone to errors. According to that theory, complex systems have interactive complexity (the presence of events in the system that are unplanned, unfamiliar, and unexpected); common mode connections between components (interaction between a unit and more than one subsystem); and unfamiliar or unattended feedback loops (presence of many control parameters with potential interactions, indirect or inferential information sources, and limited understanding). Successful technologies, according to Kulper, reduce the potential for human error by automating tasks that require high levels of accuracy and repetition.

The commentary looks at various aspects of medication ordering, preparation, and dispensing and the role they can play in medication errors.

Interpretation and transcription. The reading

and entry of an order into an information system are responsible for some 12% of medication errors and likely result from poor handwriting, workplace complexity, and confirmation bias. Computerized prescriber order-entry systems (CPOE) target these errors by eliminating the process. Orders entered into a CPOE system are checked for accuracy and completeness and compared against clinical decision-support rules. While some studies have demonstrated the ability of CPOE systems to reduce medication errors, others have disputed the claim that they cut errors. Kulper says that COPE-related errors underscore the need for appropriate system and process design and high-quality hardware.

Decision-support systems. Although most current CPOE systems have fully integrated medical logic alerts for order management, many decision-making processes are performed in the pharmacy, according to the commentary, and use of decision-support systems in sites with CPOE is highly variable. Kulper says there is little question that alerting systems need to be overhauled to provide clinicians with accurate and meaningful alerts. Each alert should be assessed for evidence, relevance, patient-specific risk factors, and frequency. And less serious alerts should be presented in an unobtrusive manner.

Preparation of IV medications. Automatic compounding machines are described as closed systems that prevent external contamination caused by multiple manipulations. Some contemporary compounding machines also use bar-coding technology to ensure correct product selection. So far, deployment of the machines in hospitals has been limited because they cost a lot to buy and not all IV compounds can be made in them.

Unit-dose repackaging. American hospitals use unit-dose distribution because it has a significantly lower error rate than multiple-dose systems. However, the commentary says, unit-dose repackaging has shifted dose preparation from nursing to pharmacy, creating a new source for pharmacy errors. Unit-dose repackaging is largely a manual process and in addition, bar codes must be added in facilities that use them, which means there is another manual process that can be a source of errors.

Kulper says bar-coded verification is included in next-generation high-volume repackaging machines. Such devices repack bulk medications into unit-dose packages including either patient- or batch-specific information. Bar-code verification is said to prevent improper loading of high-speed packagers and allow batch-specific information such as expiration dates to be tracked. "Bar-coding technology, which has an error rate of about 1 in 10 million, has great potential for reducing medication errors," he says.

Dispensing. Selection of a drug product for dispensing is repetitive and complicated by upstream processes and the interruptions of daily pharmacy work, the commentary authors say. The dispensing error rate has been determined to be between 1.7% and 2.1%. While hospitals often use unit-based cabinets for dispensing drugs, filling those cabinets is prone to error, accounting for 7.1% of the errors reported to Medmarx in 2002, more than five times the number of errors reported due to unapproved abbreviations.

Kulper says that bar-coding technology has been suggested as a potential remedy to cabinet stocking errors. In such a system, each item is labeled with a bar code and the code is scanned before the item is loaded into the cabinet. He notes, however, that institutions that have implemented bar-coded checks for loading the cabinets tend to check only one of the items to be loaded into a slot and not each individual item. Issues also arise when medications are accidentally mixed after stocking due to overflow or returns. Selection of incorrect medications and medication expiration are problems that can occur with open-shelf storage of drugs. Although many pharmacies have taken steps to reduce selection errors, confusion over similar drug names still accounts for 10-15% of all Medmarx reports.

Distractions. A national study of medication dispensing showed an error rate around 1.7% due to distractions such as answering telephones, fielding inquiries, and managing inventory. But a study of highly-automated mail-service pharmacies

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found a significantly lower error rate at 0.075%. Kulper says the difference was attributed to implementation of technology and segregation of duties within the pharmacy. He says hospital pharmacies should consider segregating duties as assigning staff dedicated to individual tasks will likely reduce medication errors.

Pharmacies and pharmacists are key stakeholders in the medication use process, Kulper concludes, and it is important for members of pharmacy departments to take leading roles in reducing medication errors and examining the effects of technology and process change on medication errors. ■

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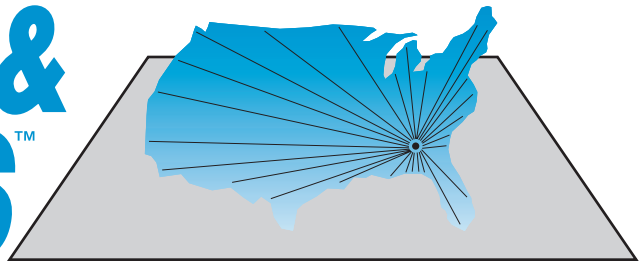

Covering PONV from "A to Z"

By **Andrew East**, PharmD Candidate, Auburn University

Postoperative nausea and vomiting (PONV) is an ever-present matter in the hospital setting that can occur in up to 30% of surgical patients and in up to 70-80% of high-risk individuals. The burden upon the health care system can be measured in cost, length of stay, nursing time, and overall patient well-being. With this in mind, prevention of PONV is important to the health and welfare of patients.

Nausea and vomiting pathway

The nausea and vomiting pathway involves a complex series of neurotransmitters and receptors leading to physiologic changes. Nausea and vomiting are stimulated by areas in both the brain (chemoreceptor trigger zone [CTZ], the vestibular system, and cerebral cortex) and GI tract (the visceral afferent nerves), and different receptor systems are involved with these specific areas. The CTZ is stimulated by serotonin ($5\text{-}HT_3$), dopamine (D_2), and neurokinin receptors (NK_1); the cerebral cortex is stimulated by sensory input; the vestibular system by histamine (H_1) and muscarinic receptors; and the visceral nerves by serotonin ($5\text{-}HT_3$), dopamine (D_2), and neurokinin (NK_1). These different receptors are the sites of action for the drugs used to treat and prevent PONV.

Risk factors

To effectively treat PONV, patients must be assessed for risk factors associated with the patient or the surgery itself that can contribute to nausea and vomiting. Certain surgical factors including the type of anesthetic used and type of surgery (abdominal, gynecological, orthopedic, ear, nose, and throat procedures) place patients at a higher risk of PONV. General anesthesia, volatile agents, and inhalation agents also increase a patient's risk. Patient factors include female gender, history of motion sickness or PONV, and use of opioids in the postoperative period. Smoking is considered a protective factor in PONV. Patients with one or fewer risk factors have a 10-20% incidence of PONV, and 80% of patients with two or more risk factors have an incidence of PONV.

Reduction of risk factors is the first step to help prevent PONV.[1] Using regional anesthesia instead of general anesthesia, and using intravenous agents such as propofol instead of nitrous oxide and volatile inhaled anesthetics reduce risk factors. The use of NSAIDs instead of opioids, minimizing the use of neostigmine, appropriate hydration, and providing 80% oxygen postoperatively can also lower the chance of PONV.

Prevention and treatment

Non-pharmacological methods can also be used to combat PONV. Acupressure (the use of a wristband to apply pressure to the P6 point on the inner wrist), acupuncture, electroacupuncture, or nerve stimulation can help reduce nausea and vomiting, and acupoint stimulation combined with ondansetron has been shown to act more effectively than ondansetron alone. The use of ginger and aromatherapy showed no benefit in the prevention of PONV.

There are currently eight classes of drugs that are used to prevent PONV:

- phenothiazines
- anticholinergics
- antihistamines
- butyrophenones
- substituted benzamide
- corticosteroids

- serotonin antagonists
- neurokinin 1 antagonist

These treatments offer at best a success rate between 40% and 50%, which is only seen in high-risk individuals.

Adverse effects

The older phenothiazines, anticholinergics, and antihistamines are highly associated with sedation, dry mouth, lethargy, and other adverse effects. Extra-pyramidal symptoms, sedation, and tachycardia are known adverse effects of the butyrophenone and substituted benzamide classes. The corticosteroids can cause hyperglycemia, gastrointestinal distress, insomnia, and facial flushing. The newer drug classes of serotonin antagonists (i.e., dolasetron and ondansetron) and the neurokinin 1 antagonist (aprepitant) are usually only linked to the adverse effects of headache, fatigue, and hiccups, and with their increased effectiveness this has made them the new workhorses for the prevention and treatment of PONV.

Clinical trial

A recent trial compared 125 mg aprepitant PO, 40 mg aprepitant PO, and ondansetron 4 mg IV to determine the proportion of patients with complete response 24 hours after surgery.[2] The aprepitant 40 mg PO and ondansetron 4mg IV are FDA-approved doses to prevent PONV; the aprepitant 125 mg PO is an unapproved dose for this indication. Complete response was defined as no vomiting and no use of rescue therapy. The study showed no statistically significant difference between the three groups with respect to complete response. No significant difference was seen in the incidences of serious clinical adverse events. Both aprepitant groups delayed the time to first vomiting and had larger proportions of patients that experienced no vomiting.

Cost

Cost-effectiveness is another key issue when talking about the prevention of PONV; this includes both direct and indirect costs. Direct costs include drug acquisition, nursing time, and delayed release from post-anesthesia care unit. Indirect costs can be measured in delayed discharge, hospital readmission, and loss of patient income. It has been shown that high-risk patients that do not receive prophylaxis may incur overall costs 100 times greater than if an antiemetic is used. The easiest and most cost-effective method to reduce PONV is to take steps to eliminate surgical and patient risk factors. The AWP listed price for aprepitant 40 mg is $35.88 and for ondansetron 4 mg vial is $0.76.

Summary

Evidence-based literature supports the use of ondansetron for the prevention of PONV. Ondansetron was recently approved as a generic product, which has significantly reduced its acquisition cost. Although the other therapies are effective at preventing PONV, with its safety and efficacy equal to the more expensive aprepitant and greater than that of the older drug classes, ondansetron should be used preferentially in the prevention of PONV.

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Are we numb to the dangers of topical anesthetics?

By **Erin Bedard**, PharmD Candidate, Auburn University

An FDA Public Health Advisory has been issued regarding the use of topical anesthetics, specifically lidocaine, tetracaine, benzocaine, and prilocaine administered in a cream, ointment or gel for cosmetic procedures.[1] This warning follows the report of many fatalities resulting from the use of these agents.

The FDA sites two reports of women who used topical anesthetics prior to laser hair removal to decrease the pain during the procedure. They each used compounded creams containing high concentrations of the active ingredient and wrapped their legs in plastic wrap following application, increasing the absorption of the anesthetic. The combination of high drug concentration and increased absorption resulted in toxic serum levels, which ultimately led to their death.

This warning from the FDA, though specific

for topical creams prior to cosmetic surgery, should serve as a reminder of the potential dangers of all topical anesthetics no matter what dosage form. There are case reports of topical anesthetic toxicity resulting from the use of OTC vaginal creams, lozenges, topical teething preparations, and anesthetic sprays used prior to endoscopic procedures.[2-5]

Serious and possibly fatal adverse reactions resulting from these agents include systemic toxicity and methemoglobinemia. Toxic effects are due to fast sodium channel blockade and include respiratory depression, central nervous system disturbances, and cardiovascular collapse.[6,7]

The first signs of systemic toxicity are tinnitus and metallic taste; the patient then could become drowsy, light-headed, agitated, or talkative. The patient may develop tonic-clonic seizures and eventually respiratory and cardiovascular depression.

Methemoglobinemia is an elevated concentration of hemoglobin that is incapable of carrying oxygen and results in impaired oxygen delivery, cyanosis, and characteristic chocolate brown blood. Methemoglobin is formed when the ferrous iron (Fe^{2+}) in hemoglobin is oxidized to ferric iron (Fe^{3+}) due to the oxidizing properties of the anesthetic agents.[7]

Factors that put the patient at high risk for serious adverse events include using a product with a high concentration of anesthetic and using a large amount of product covering a large surface area for an extended duration. Increased rate of absorption, caused by wrapping of the skin following administration, application to broken or irritated skin, and absorption through skin with an elevated temperature (i.e., from exercise or the use of a heating pad) can also increase the risk for toxicity.

To increase safety with the use of these agents, the FDA recommends the following when using a topical anesthetic:

- Use a topical anesthetic approved by the FDA. Product approvals can be found in the Orange Book or on the FDA web site.
- Select a topical anesthetic containing the lowest dose possible to relieve the pain.
- Educate the patient on how to safely use the topical anesthetic: Apply as little cream to cover the affected area for the shortest amount of time possible. If wrapping the skin, be aware that this may increase the risk for side effects.

Employing these recommendations will improve the safe use of these agents; however, we must continually alert patients of the danger associated with their use. These products may seem benign because some are available over-the-counter and they do not carry clear warnings of potential toxicity on the labeling. As health care practitioners, we need to educate patients of their dangers and proper use and recognize the signs of topical anesthetic toxicity if a patient presents for care.

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Most pediatric chemo errors affect patients

Researchers have found that the majority of chemotherapy errors for children with cancer affect the patients. They also found the errors are more often caused by dispensing or administration mistakes than by prescribing mix-ups.

The study, published in the journal *Cancer*, led by **Marlene Miller**, MD, associate professor of pediatrics at the Johns Hopkins School of Medicine, Baltimore, found that 85% of the drug errors were not noticed until the child receive the medication. While not all the errors harm the patients, the authors said, they always are worrisome.

Miller and her colleagues obtained their data by analyzing Medmarx, the United States

Pharmacopeia's voluntary medication error reporting database. They found that prescribing errors accounted for only 10% of cases in patients under age 18 from 1999-2004. Rather, most of the mistakes arose from dispensing errors by pharmacy staff or administration problems involving nurses and other health care workers.

A total of 310 chemotherapy errors for pediatric patients from 69 different institutions were found in the review of Medmarx data. More than 80% of the errors reached the patients, meaning they were not caught before the drug was administered, and about 16% required an escalation of care, Miller said.

Most errors (48%) involved mistakes in drug administration, with another 30% being errors in dispensing. The most commonly cited types of error were mistakes in dose or quantity (23%), or time of administration (23%), followed by failing to deliver the drug at all (14%) and improper administration technique or route (12%). The biggest cause of error was listed as "performance deficit," a nice way of saying "human error," which came in at 41%.

Miller said children are more susceptible to medication errors than adults because there is no "usual" dose for children since pediatric doses generally vary with body size. She said the problem is even greater for anticancer medications because they are very potent drugs and their therapeutic window is narrow. "I can give four times the normal dose of Motrin and you will be fine," Miller told the news media. "You cannot do that for chemo; they have a very narrow safety window."

She said that while many hospitals use computer systems to compute proper dosages in hopes of reducing errors, the systems often don't cover chemotherapy agents because the rules for dosing and protocols for administering the drugs are constantly being revised as new clinical trial data appear.

Miller said her study cannot be considered as having reported the actual rate of chemotherapy errors. To calculate that number, she said, one would need to know the total number of chemotherapy doses administered. Also, since Medmarx is a voluntary database, some errors go unreported.

"It is impossible to be vigilant on everything, to never make an error, never be late," she said. "So our struggle is to introduce something to make it more error-free. ■

CE *Questions*

Pharmacists participate in this continuing education program by reading the article, using the provided references for further research, and studying the CE questions. Participants should select what they believe to be the correct answers.

Participants must complete a post-test and evaluation form provided at the end of each semester (June and December) and return them in the reply envelopes provided. A statement of credit requires a passing score of 70% or higher. When a passing test and evaluation form are received, a statement of credit and answer guide will be mailed to the participant.

This CE program will improve participants' ability to:

- **Compare** the clinical efficacy and safety of one therapeutic agent over another used in the same setting.
- **Assess** clinical trial data and explain how the results influence formulary decision making.
- **Perform** cost-effectiveness analyses.

17. Postoperative nausea and vomiting may occur in what percentage of high-risk individuals?
    A. 30%
    B. 50%
    C. 60%
    D. 70-80%

18. Ondansetron should be used preferentially in the prevention of PONV because:
    A. It is safe.
    B. It is effective.
    C. With a generic product available, it is cost-effective.
    D. All of the above

19. The FDA recently released a Public Health Advisory has been issued regarding the use of which of the following topical anesthetics?
    A. Lidocaine
    B. Tetracaine
    C. Benzocaine
    D. Prilocaine
    E. All of the above

20. The FDA warning on topical anesthetics was specific to:
    A. dental surgery.
    B. cosmetic surgery.
    C. emergency surgery.
    D. gynecological surgery.

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Salary survey results follow trends

Hospital and health system pharmacist salaries revealed in *Drug Formulary Review's* 2007 salary survey are following industry trends. "The salary numbers look about right, given that pharmacy salaries tend to start high and then flatten," says **Barry Browne**, PharmD, Coordinator of Drug Information Services at Scott & White Hospital, Georgetown, TX. "All else looks reasonable as well, and what I would have expected."

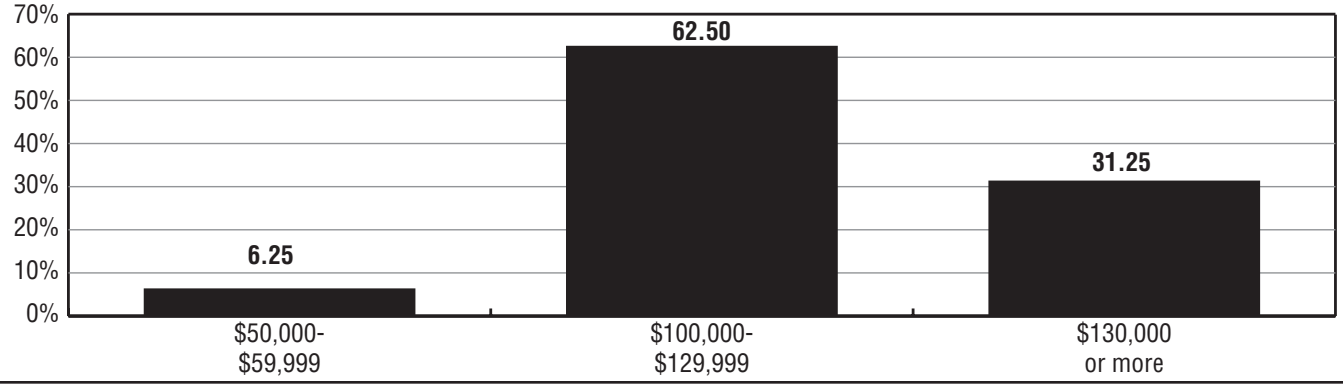
The most significant concern with the survey results is the small number of responses from which to draw conclusions. "The survey in general is fine. I just think the numbers are small," says **Nadine Balady**, PharmD, Director of Pharmacy Services at High Desert Hospital, Los Angeles County, CA. "The survey needs to have a more widespread distribution."

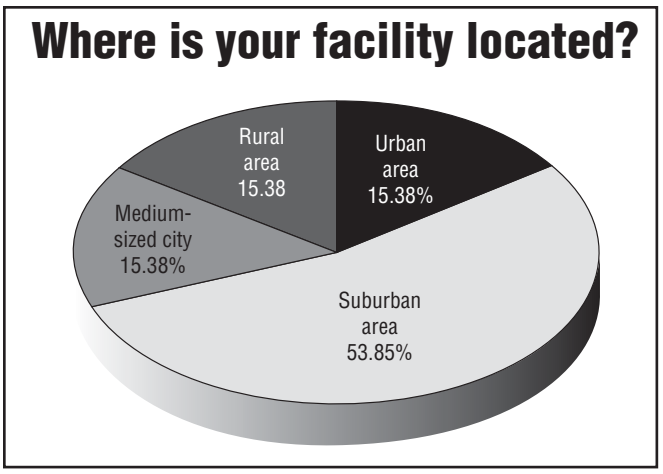
Some 75% of respondents hold the title of director of pharmacy, while 6.25% of responses were from clinical pharmacist/coordinators, and 18.75% had other titles. There was a wide distribution among respondents in terms of the highest academic degree held. Thus, 28.57% held an MS, 21.43% an MBA, 14.29% a PharmD, and 35.71% other degrees.

There was an even split among respondents between men and women. Most were between 51 and 55 years old (42.86%), while 35.71% were between 56 and 60. Only 7.14% of respondents were between 31 and 35, between 36 and 40, or between 61 and 65.

The vast majority of respondents earn more than $100,000 per year from their pharmacy position **(see chart, below)**. Thus, 62.5% reported pay between $100,000 and $129,999 and 31.25% said their pay was $130,000 or more. Only 6.25% reported a gross salary between $50,000 and $59,999. The pay levels seem

What is your annual gross income from your primary health care position?





consistent with the age and job titles of the respondents.

Slightly more than half of the facilities responding (53.85%) are located in the suburbs, with 15.38% each in urban areas, medium-sized cities, and rural areas **(see chart, above)**.

As noted by Browne, pharmacist salaries tend to flatten, and that is seen in the response. Some 60% of respondents reported a salary increase of 1-3% in the last year **(see chart, below)**. There was no change in salary for 20% of respondents, while 13.33% received a 4-6% increase and 6.67% received an increase between 7% and 10%.

The vast majority of respondent institutions were hospitals (93.33%), while only 6.67% were an academic medical center. There was a fairly even distribution of respondents through three of the four regions. Thus, 37.5% were in Region 1, 31.25% in Region 2, 25% in Region 3, and 6.25% in Region 4.

More than 80% of respondents' facilities were owned by non-profit organizations, with 12.5% owned by city, county, or state governments, and 6.25% owned by a for-profit company.

Again, consistent with the salary levels reported, 73.33% of respondents have worked in pharmacy for more than 25 years, while 6.67% worked in the field between seven and nine years, between 10 and 12 years, between 13 and 15 years, and between 22 and 24 years. Likewise, most respondents have worked in health care for a long time. Some 80% have been in health care for more than 25 years, with 6.67% reporting health care tenure of 7-9 years, 10-12 years, or 13-15 years. All respondents said the RPh best describes their certification.

Respondents work long hours to earn their salary **(see chart, below)**. Some 40% report working 41-45 hours a week, while 20% work 46-50 hours weekly, and 13.33% work 51-55 hours.

Most respondents (40%) work in a hospital with 201-300 beds. Another 20% work in hospitals with 301-400 beds. Some 13.33% work in hospitals with 101-200 beds, and 6.67% work in one of several other categories—fewer than 100 beds, 501-600 beds, 601-800 beds, and 801-1,000 beds. ■